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A SUB-ARCTIC GLACIER CAP: THE WEST ICE OF NORTH EAST LAND

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THE glaciological research of the Oxford University Arctic Expedition 1935–36 was mainly concentrated on the West Ice of North East Land, but subsidiary observations were also made on other glacier caps. Part of the results have already been published. The object of this paper is to bring together the whole and to give a detailed description of the West Ice alone. In this way a picture can be given of what is believed to be a characteristic Sub-Arctic glacier cap.

A tribute must be paid to the value of the previous work in this area, in 1924 by Dr. K. S. Sandford and in 1931 by Professor Ahlmann. Without the knowledge which was derived from their work, the 1935–36 programme could not have been carried out. The studies of Mr. Gerald Seligman on Alpine Glaciers have also been of the utmost value, and to each one of the above the 1935–36 expedition is greatly indebted for his unstinting assistance. The greater part of the physical research in North East Land was done at the central West Ice station by Mr. Moss, but useful information on marginal conditions, on glacial drainage, and on the geomorphology of the area was collected by Mr. J. W. Wright, and by Mr. A. Dunlop-Mackenzie.

So many glacier classifications have been put forward during late years that the primary need would now seem to be the adoption of one system as a standard. Professor Ahlmann in 1933 suggested a dual system of classification, Physical and Morphological, which will be followed in this paper.[1] His classification of physical types, Temperate, High-Arctic, and Sub-Arctic glaciers, will be amended in one particular. Ahlmann makes no mention of ice bands in his description of Sub-Arctic glaciers, therefore it is suggested that: "Sub-Arctic glaciers consist, at least in their accumulation areas, of crystalline firn, with intermittent ice bands, down to some considerable

[1] H. W. Ahlmann, "Contribution to the physics of glaciers," *Geogr. J.* 86 (1935) 102. *Ibid.*, "Results of the Swedish–Norwegian Arctic Expedition, 1931," *Geogr. Ann. Stockh.*, vol. 15, p. 213.

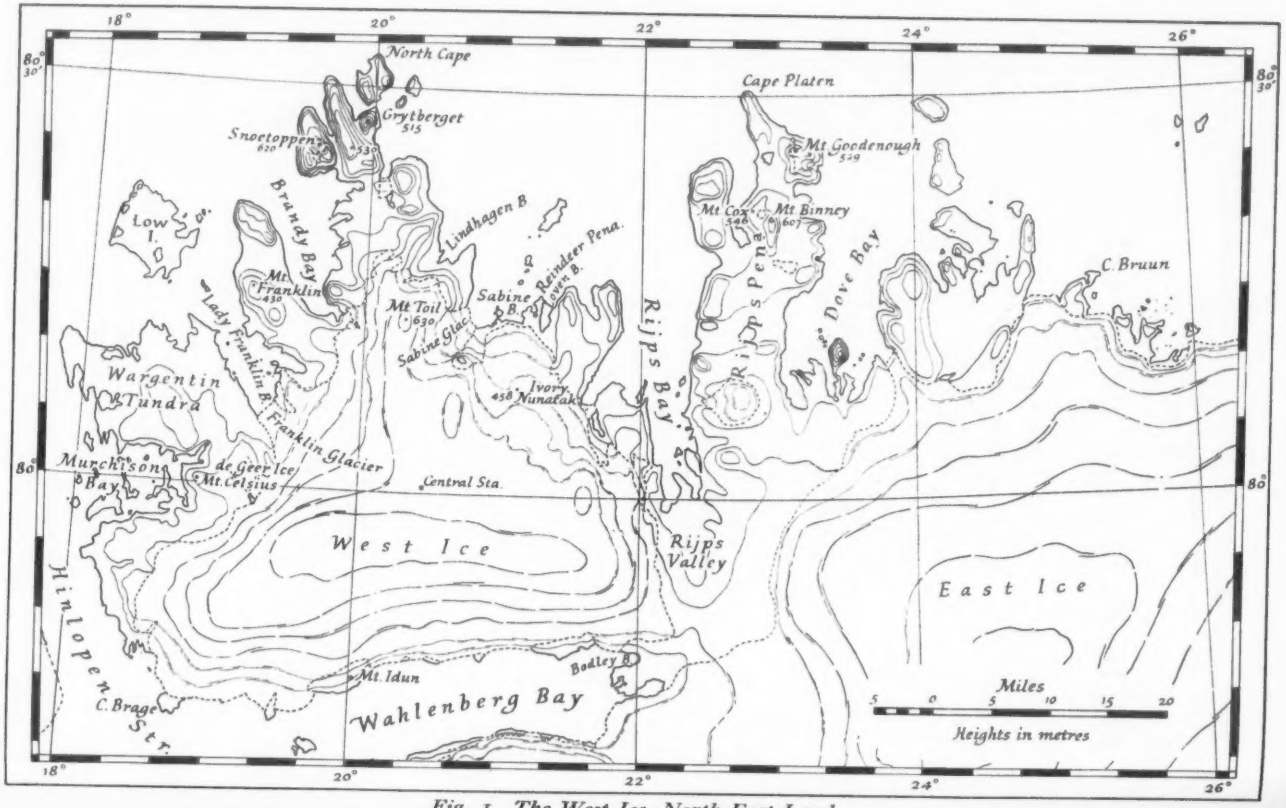


Fig. 1. The West Ice, North East Land

depth " should replace Ahlmann's "Sub-Arctic glaciers consist, at least in their accumulation areas, of crystalline firn down to a depth of some 10 or 20 metres." It is the influence of water, shown in the existence of the intermittent ice bands, which differentiates the Sub-Arctic from the High-Arctic glaciers.

The observation of Odell and Wager on certain of the Himalayan glaciers, and especially on those of the Mount Everest district, have indicated that it will probably be necessary to define a fourth type distinct from those of Ahlmann.

The West Ice occupies the greater part of the north-western sector of North East Land, being bounded to the south by Wahlenberg Bay and to the east by Rijps Bay and the Rijps Valley. Its surface features are undoubtedly controlled by the subglacial topography, and its high areas are limited to the inverted T-shaped framework formed by the east to west ridge running parallel to Wahlenberg Bay, and by the extension from this ridge northwards to the Sabine Massif, and to two rounded hills, one of which, Mount Toil, is south of Lindhagen Bay, and the other west of the head of Rijps Bay (Fig. 2). The Franklin and the Rijps Glaciers provide the main outflows to the north, the other glaciers on the north coast being entirely static. To the south however there is greater activity, and three glaciers with sea faces terminate in Wahlenberg Bay. Where Wahlenberg Bay meets Hinlopen Strait, the West Ice ends in ice-cliffs, broken at frequent intervals by patches of ice-free land such as Cape Brage, or by the numerous small outcrops that protrude from beneath the ice-cliffs.

The highest point of the glacier cap, on the main east-to-west ridge, probably does not exceed 650 metres, while Mount Toil is 630 metres, and the dome to the west of the head of Rijps Bay around 610 metres. In general the gradients are gentle except where the ice forms a thin covering over some steep-sided hill such as Mount Toil.

Several nunatakkr break the surface of the glacier cap. On the south side of the Franklin Glacier a succession of them run inland south-easterly for some 5 or 6 miles. Immediately inland from the head of Brandy Bay there are three granite nunatakkr. Small rock outcrops girdle Mount Toil, and there are several outcrops on the northern and western sides of the dome to the west of the head of Rijps Bay. The most important nunatakkr however are a few miles south of Lovén Bay, the largest being the Ivory Nunatak which is over 2 miles long from north-east to south-west, and which reaches a height of over 200 metres above the surrounding land surfaces.

The altitude of the margin of the glacier cap varies from sea-level up to more than 500 metres on the Sabine Massif. Apart from the Franklin Glacier, the Rijps Glacier, and some of the glaciers flowing into Wahlenberg Bay, the altitude at which the glacier cap terminates appears to be controlled almost entirely by topographical features, the general condition of the ice being static.

No seismic measurements have been made on the West Ice, so there is no exact information as to the thickness of the glacier cap. It is nevertheless possible to make tentative estimates on indirect evidence. The aerial photographs taken by the Norwegian expedition in 1938 reveal that in the south-

Fig. 1. The West Ice, North East Land

west corner of the West Ice there are frequent rock outcrops beneath the glacier faces. The impression is given therefore that the average thickness of these glacier faces does not exceed 20 or 30 metres. On the south side of the Franklin Glacier a series of rock outcrops continue up to a height of 350 metres, and the configuration of the surface suggests strongly that the ice on the valley sides is extremely thin. Immediately to the east of Brandy Bay nunatakkr outcrop at a height of 420 metres, and the ice-plateau to the east does not exceed 450 metres. The regularity of the nunatakkr summits suggests a rock plateau, in which case the thickness of the ice cannot exceed 30 or 40 metres and is probably considerably less. Rock outcrops on Mount

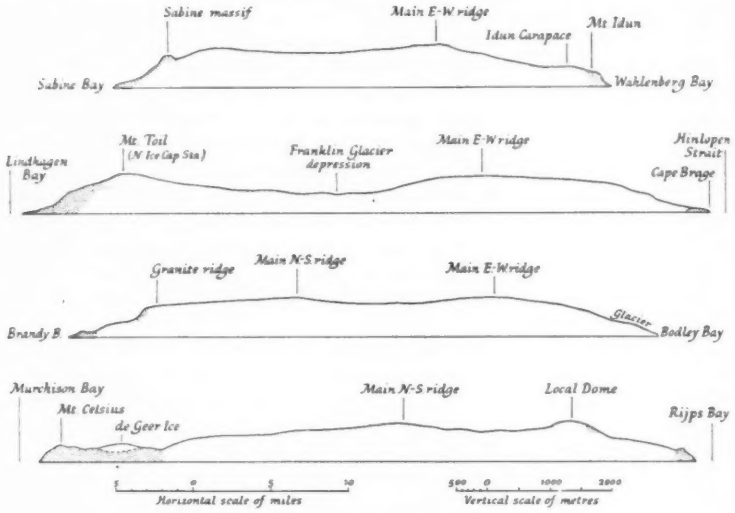


Fig. 2. Sections of the West Ice

Toil up to a height of 480 metres, and is evidently continued to a much greater height to form a hump-backed massif, the summit of which may be covered by ice not thicker than perhaps 30 or 40 metres. At the Ivory Nunatak, J. W. Wright was able to penetrate below the main glacier cap, and gained the opinion that the thickness of the ice between there and Sabine Bay probably did not exceed 30 metres. On the ice dome to the west of Rijps Bay rock outcrops up to a height of 500 metres, and a similar thickness to that on Mount Toil is suggested.

In considering this evidence it must be stressed that wherever the ice is seen to end in a cliff, the thickness is never greater than 20 metres. Most of the glaciers with sea faces are aground and a similar figure is indicated. Where the ice terminates on the edge of a hill-side never more than 40 metres is suggested by the profile. With the evidence already given, these figures suggest that the marginal zones of the glacier cap rarely exceed 50 metres in thickness. No estimate of the ice thickness on the east-to-west ridge can be

made, beyond saying that Ahlmann's suggested maximum of 125 metres would seem reasonable. It therefore appears that only in the valleys can the thickness of the ice reach any large figure, and even there it is unlikely that 300 metres is ever exceeded.

Marginal conditions and glacier movement

In general the ice runs down to the land in a comparatively gentle gradient, the actual termination often being a feathering out of the ice. The terminal slope rarely exceeds 20 degrees, and only in one place does the ice end in a perpendicular cliff or Chinese Wall: which is small and is restricted to some 30 yards of the ice boundary. The most remarkable feature of the margin is the position of the terminal moraine. This is usually found, not at the actual ice land boundary, but set back perhaps 40 or 50 metres on the terminal ice slope. For this there are two possible reasons.

It might be argued that the moraines are formed at the true ice edge, but that the ice slopes below have been formed by the accumulation throughout the years, of drift snow deposited in the lee of the moraines. Undoubtedly deposition of this kind does occur on a considerable scale, and it is known to be sufficient to maintain many small glaciers in the North Cape region. The moraines frequently reach a height of 100 metres or more above the surrounding land, and, if the ice were to retreat, the moraines would be left as a feature quite distinct from any in this area at the present time. It would be strange if the glacier cap is now building up a large terminal moraine, a process which apparently it has never accomplished before. It would be doubly strange if it was doing this in the weather and ice conditions now prevailing.

It would therefore seem more reasonable to believe that the moraines are of no great thickness, with the consequence that, as the origin of the moranic material must be subglacial owing to the virtual absence of nunatakkr, the ice must be thin also. In this case the height of the moraine above the surrounding land is caused by the ice terminating either on a raised plateau or on a series of hills. The snow or ice slopes below the moraine are caused by the deposition of drift snow below the scarp of the plateau or the hill-sides. The moraine itself is thus just a thin surface scraping, originating from the subglacial land.

This explanation agrees with what is known of the generally static state and prevailing thinness of the West Ice. Additional supporting evidence is given by the rocky cliff edges which form mock moraines behind Mount Idun or around Mount Toil. In the Rijps Valley the rock sides appear to be formed of a series of steps. The same set-back moraines occur, but the moraines too are in series. The snow or ice slopes become narrower as the steps descend.

There is little prior information on which to base any large conclusions on changes in the terminal positions of the glaciers. The surveys of Professor de Geer in 1899–1900 do give accurate knowledge however of the position at that time of the southern branch of the Franklin Glacier. In 1936 it was found that this glacier had retreated $1\frac{3}{4}$ miles since 1900. This is the one case of exact information, though Captain Ohlsen believes that the Lindhagen Glacier has retreated about the same distance within a similar period. It is also worth recording that Duner's map, drawn in 1865, shows a glacier

forming the head of Brandy Bay; this suggests a retreat of not less than 1 mile in seventy-five years. Duner and Nordenskiöld established an astronomical station on the hill immediately to the north of the Franklin Valley, from which a perfect view can be obtained of the interior of Brandy Bay, so there is no reason to doubt their report.

It was unfortunately impossible to make any measurements of the movement of the glaciers during the 1935–36 expedition. This was a grave omission, but we were fully occupied with establishing the two stations on the West Ice. Nevertheless it is not impossible to make tentative estimates of the rate of movement.

The remarkable absence of icebergs, not only from the sea surrounding North East Land, but even from the bays which actually have glaciers at their head, shows the general stagnancy of the Ice Cap. The few icebergs that are found are very small. All the glaciers with sea faces appear to be aground, with the possible exception of some of those flowing into Wahlenberg Bay. Only small fragments were observed breaking off the glaciers.

When the snouts of glaciers were visited during the winter, little disturbance was found on the bay ice against which they were pressing. The Wahlenberg Bay glaciers by June had formed on the bay ice a succession of pressure ridges, but these could not have represented a movement of more than 75 metres in a period of between six and eight months. The Franklin Glacier produced a pressure area somewhat smaller in width, with a movement of perhaps 50 metres in a similar period. The bay ice in front of the Sabine Glacier was absolutely undisturbed, therefore proving its complete stagnation. There is no information regarding the glacier which flows into Rijps Bay because the bay ice in front of it was disturbed by pressures of different origin. From its characteristics however it would appear that the rate of movement of at least the southern branch may be somewhat greater than that of the glaciers flowing into Wahlenberg Bay. The slope is steep, and two ice falls separate heavily crevassed plateaux. Considerable activity was witnessed whenever any observations were made on this glacier.

It appears that the maximum rate of movement of the glaciers may not exceed 2 feet per day. Furthermore this rate applies to the few valley glaciers, whereas the great mass of the glacier cap must be almost literally stagnant. This rate of movement, when compared with that of certain of the Greenland glaciers, which may be as much as 50 feet per day, gives good reason for the description of the West Ice as dynamically inactive. This is what would be expected, for the ice is thin, and the prevailing gradients gentle. Moreover the West Ice is not constricted by mountain ranges as in the Greenland glacier cap, and there is thus no piling up of the ice against the mountain wall. In Greenland the glaciers which do penetrate the mountains have steep gradients and a great press of ice to relieve. In North East Land the conditions are exactly the opposite.

Minor structures of the West Ice

The crevasse formations on the West Ice have been described in great detail by Sandford. Descending from the high ridge above Wahlenberg Bay towards the bay by one of the larger valleys, the first crevasses encountered

Phot. D. B. Keith

Glacier stream, Ivory Nunatak right distance

Lindhagen Bay

Phot. N. A. C. Croft

Undulating country, Platen Peninsula, 1936 Phot. J. W. Wright

Franklin Glacier Phot. N. A. C. Croft

Sabine Bay and glacier Phot. D. B. Keith

are small and regularly placed, running in straight lines across the valley, and appearing almost like contours. As the slopes of the ridge are finally left behind, the amphitheatre at the head of the valley is reached. There the crevasses are still placed contourwise, but they have become much more frequent, and are spaced every few yards; their width has increased greatly, and occasionally they are joined by cross crevassing, thus leaving only isolated platforms of sound ice.

Sandford has shown that the crevassing of the amphitheatre sides as well as of the valley beyond suggests that the ice is flowing into a simple steep-sided rock valley from its sides as well as from its head. There is little sign of overthrusting, and the contours bend up and not down valley. Conditions are thus very different from those on the typical alpine glacier, and suggest that movement is relatively little.

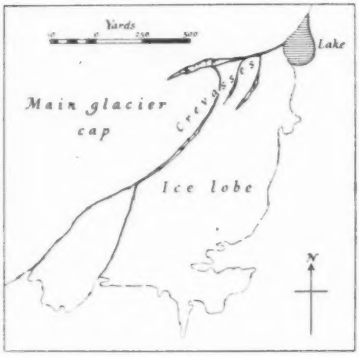
Some of the ice valleys head in fairly steep embayments, which may even be marked by ice falls. Where this occurs the ice gashed by wide crevasses can often be mistaken for rock outcrops. In addition to the contour crevassing, transverse crevasses sometimes occur, forming a type of sheer crack which appears to separate the valley side from the ice slopes above. If the rate of movement on each side of such a crevasse could be measured, it would be of great interest. Transverse crevasses may be very similar to the discordant junctions found by Odell in certain East Greenland glaciers, and in North East Land it is not impossible that a valley glacier might be bordered on each side by stagnant ice. In certain localities whale-backed ridges rise often as much as 100 metres above the general level of the valley, the ridges being scarred by wide crevasses. The longer axis of these ridges was always orientated up and down the valley, and sometimes the pressure was so great that blocks of ice had been broken off and uplifted into cones like those found on sea-ice.

The crevasse found at the central West Ice station gave a unique opportunity for investigation of the lower parts of the glacier cap. The crevasse itself consisted of three galleries, the floor of one forming the roof of the other. The galleries kept more or less consistent levels, and it would seem that the divisions between them were formed of the remnants of old snow bridges which had collapsed, but which had been caught at certain levels, the snow being later changed into ice. The curtains of icicles bore witness to the effects of downward percolating water, and the clusters of ice crystals to the effects of water vapour. At the bottom of the crevasse, at a depth of something over 20 metres, was a pool of water, the surface of which was unfrozen when first discovered in March. The most remarkable features of the crevasse were the absence of any sign of it at the surface, and its vast englacial ramifications. The first indicates that it was shaped like a bottle, its upper levels being narrow, while it broadened at first with depth. The pool of water continued indefinitely in one direction, while low-roofed passages led in others. This multitude of passages suggests that ideas on the relative simplicity of the lower parts of crevasses have to be somewhat revised.

The important rôle played by the crevasses in englacial and subglacial drainage must be stressed. Sandford was quite correct when he emphasized this aspect of the summer ablation period. Sometimes the water carried in

this way from higher levels attains such a pressure that it literally bursts its way out through the ice, sending up a small waterspout which may continue for as long as an hour, then dying down into a more gentle fountain. Surface drainage is also of major importance, and the depth and size of the torrent beds that can be cut by streams of water little if at all above freezing-point, and without any load of silt or gravel, is remarkable. It seems as if many of these drainage streams become permanent features of the glacier caps, features which will be used again by the thaw streams of another summer. The banks of snow which are hurled up in the original excavation of the stream bed are turned to ice, and it is not unusual to see an embedded stream flowing at a level appreciably above that of the surrounding ice surface.

A remarkable feature is found in that part of the West Ice which terminates in Rijps Valley some 5 miles or so north of Wahlenberg Bay. It is revealed perfectly in the aerial photographs taken by the Norwegian Expedition in 1938, and is shown in the accompanying sketch-map which is taken from one of the photographs by courtesy of Dr. Adolf Hoel. A small lobe of ice extends from the main glacier cap some half a mile eastwards, the ice being thin, and apparently completely static. Its edges feather out and there are not even the smallest moraine scrapings around them. There is a lake at the northern end of the ice lobe, and behind the lake the slopes of the glacier cap rise steeply. From the lake a longitudinal crevasse extends to the southern end of the ice lobe, giving the impression that it represents the margin of the true glacier cap to which the ice lobe is a mere appendage. The width of the crevasse varies up to some 15 metres, and in summer it is filled with water. Two parallel crevasses are also developed at the northern extension of the ice lobe, but these do not continue south. Since the lobe is beyond doubt static, it is difficult to account for the existence of these crevasses, unless it be that, as it is covering ground which descends to the east, a slight eastward slip has developed, which has not been offset by supply from the main glacier cap. However that may be there is no doubt that this ice lobe provides an example of the important primary stage in the separation of a small ice-field from its parent glacier cap. In the Rijps Valley, in the Murchison Bay area, and around Lady Franklin Bay there are several examples of such small local ice-fields, but this is the clearest known example of the first stage in the development of such an area.



Geomorphology

In discussing the geomorphology of the region it will be occasionally necessary to extend the observations beyond the locality of the West Ice, and, in

particular, to consider the rather unusual land forms found in the Platen Peninsula.

Three morphological features have been distinguished by Ahlmann in North East Land. These are: coastal plains or strandflat, varying in height from sea-level up to around 50 metres; lowland areas between 50 and 150 metres; and plateaux between 200 and 600 metres above sea-level.

The coastal plains reach their maximum development around Murchison Bay and Lady Franklin Bay. In the North Cape district they are absent, but they have a fair development around Lindhagen Bay and Sabine Bay, the shallow parts of the continental shelf, such as the Parry and Tafel plateaux, being continuations of them. They are well developed in the east, where they are continued by the Charles XII shelf plateau. The coastal plains thus include not only the low-lying districts and wide valleys which separate the plateaux, but also their extensions along the shore which follow the base of the plateaux laterally. Respective examples are the Wargentin Tundra, the transverse valleys on the north coast such as that to the south of Cape Lindhagen or that to the south of Reindeer Peninsula, and the shoreland of Sabine Bay.

Ahlmann has dismissed the theory that faults separate the coastal plains from the higher inland, as the lines of demarcation are far too irregular. There is evidence however that faulting, as suggested by Sandford, may have played a somewhat more important part than that indicated. Ahlmann believes that the coastal plains have been formed by subaerial denudation since Tertiary times, but that this was assisted by glacial erosion during the Ice Age, and also, in certain places and at certain times, by marine abrasion. Subaerial denudation during the Tertiary uplift, which continued throughout parts of this and of the Pleistocene Period, when there was any considerable amount of running water, resulted in erosion along lines of Caledonian trend and other favourable zones. The products of this subaerial denudation formed a Piedmont plain in the outer and most developed parts of the area, while farther inland the valleys cut the plateaux into blocks. During the Glacial Period the favourably orientated valleys were occupied by the outflowing glaciers, but the transverse valleys were relatively little affected by ice erosion. Ahlmann believes that the ice accentuated the line of contact between the low-level Piedmont plain and the plateaux. With variations in sea-level throughout the Glacial Period, marine abrasion and subaerial denudation with solifluction when the ice was not a complete cover, smoothed the coastal plains.

Nansen believed that the coastal plains in Svalbard were mainly the result of marine abrasion, in which he particularly stressed such abrasion under arctic conditions. Ahlmann has opposed this view and stated that the ice-foot is more of a protective than of an erosive agent. In this he would appear to have confused Antarctic conditions with those in North East Land. As witnessed in the summer of 1936 the ice-foot undoubtedly was an agent of erosion, and this influence was also continued throughout the autumn and winter as a result of the frequent breaking up of the bay and sea-ice by the violent storms. This necessitates only a slight possible modification in the processes mentioned by Ahlmann and in no way invalidates his theory as a whole.

The lowland areas are believed by Ahlmann to be more closely related to the coastal plains than to the plateaux, in which case they would represent a denudation level formed by subaerial process at a base level of erosion higher than that of the coastal plains.

The plateaux are the remains of an older peneplain, presumably pre-glacial, and include the highest mountains in the land. These are found in the area immediately to the north of Brandy Bay, and include Snoetoppen which is 620 metres in height, Mount Grytberget 515 metres, and another summit 530 metres. Ahlmann believes that the plateaux owe their present position to changes of level which probably occurred during Tertiary times. He suggests that the alternating effects of frost weathering with solifluction and the erosion which can be accomplished by an ice cap, was sufficient to level a humpy denudation surface into the present plateaux.

The land forms of the Platen Peninsula throw some light on these views. In the north of the peninsula there is a well-developed system of valleys, many of which deepen into steep-sided gorges. These gorges, which attain depths of 20 or 30 metres, are of interest as the present streams which occupy them could not have excavated them. Even in the height of the thaw in the summer of 1936, the streams were rarely 50 cms. in depth, and did not fill their beds. In spite of the prevailing height of the land it is possible to cross the peninsula in many places without rising above 200 metres. The valleys seem more typical of a subaerial erosion surface than of a glaciated one, and the whole area appears to lack the larger features of glacial erosion. There are no cirques, no sharp peaks or arêtes, the hill-sides are gently rounded, and the valleys are not U-shaped. Nevertheless there is good evidence that most if not all of the area has been ice covered, erratics being found near the summits of the highest peaks, so it would appear that little erosion has been accomplished by the ice, and that the main land features have been determined by subaerial erosion in pre-glacial or inter-glacial times.

Four small ice-fields are to be found in the northern part of the peninsula, although there are many snowdrifts, the largest of which almost merge into the category of small ice-fields. The largest ice-field occupies the col to the south of Mount Goodenough, and has two glacier tongues which nearly reach the sea to the north, and a third glacier tongue running eastwards. The second occupies the low ground between points 480 metres and 256 metres some 3 miles south of Mount Binney, while the third occupies the col between Mount Binney and Mount Cox. The fourth is the small hanging ice-field above the inlet south-east of Mount Binney.

These ice-fields, in common with most of the others in the country,[1] are found, not as carapaces capping hill tops, but in hollows. They are fundamentally distinct from the carapace type of glacier or of ice-field, so well developed, for instance, in Iceland. Thus the hill tops of the Platen district are entirely ice free, while the cols or hollows, perhaps 400 metres below, are ice covered. It might be thought that the reason for the existence of these ice-fields is similar to that for the snowdrift glaciers in Brandy Bay, namely,

[1] Snoetoppen is the one apparent exception, but it is in fact a true glacier cap, with its own accumulation area, which is sufficient to nourish the valley glacier which runs eastwards to Brandy Bay.

excessive accumulation through the deposition of drift snow. Measurements of the year's accumulation on their summit areas in June 1936 however showed that the "snow cover" was considerably thinner than on comparable heights of the West Ice. The ice-fields had no accumulation areas, and so it is difficult to resist the conclusion that they are relics of the glacier cap that must once have covered most if not all of the Platen Peninsula. Their existence to-day is explained by the fact that it was in hollows that the glacier cap reached its maximum thickness. Support is lent to this possibility as the thickest parts of the West Ice would appear to be covering subglacial valleys or hollows.

In the study of glaciers it is possible that undue attention has been paid to glacier-front retreat, and not enough to other less immediately noticeable symptoms of a dying glaciation. A dying glaciation may be brought about by a period of deficient accumulation or of excessive ablation. The former might be more likely to occur under anticyclonic, and the latter under cyclonic conditions, although it should be remembered that Ahlmann has stressed how favourable are cyclonic conditions to the growth of glaciers and that precipitation and not temperature is the vital factor in such growth. If decline is caused by deficient accumulation, a gradually thinning process will result, but the effects of summer ablation may remain relatively small and run-off inconsiderable. As the subglacial land is revealed, no dramatic part will be played by glacier torrents, and the more gradual effects of solifluction may dominate the subaerial erosion. While if decline is caused by excessive summer ablation, run-off will be large and fluvial erosion may have rapid and predominant effect.

In the decline of glaciation in North East Land it is possible that a period of excessive summer ablation preceded the present conditions of approximate balance. In this period the river gorges were excavated. It is of course possible that the torrents which formed the gorges owed their origin merely to the greater quantity of water supplied by the larger then existing glacier caps; but this does not appear probable, as the drainage streams from the West or East Ice are at present small. It thus seems possible that a period of excessive summer ablation was sustained for some length of time in the recent glacial history of North East Land.

That period would certainly appear to be over, and the prevailing state of glaciation may well be one of approximate balance or of gradual decline. In favour of a current negative balance of glaciation is the evidence of retreat of glacier snouts, and the strong suggestion that separate small ice-fields are still being stranded by the deterioration of parent glacier caps, for example in the Rijps Valley. Before any more definite conclusion can be reached regarding the current balance of conditions, more information is required.

A second and more important feature, apparently of the greater part of the whole declining trend of glaciation, is the predominant stagnancy of the glacier cap. For the most part however there seems to have been no distinctive retreat of the ice edge towards a central zone, but instead a general thinning of the glacier cap over its whole area. Thus relic ice-fields have been left in the hollows where the ice was thickest, while all hill tops below the firn line tend to be ice free. There is a virtual absence of old terminal moraines, and the moraines that are now found up the terminal ice slope have been seen

to be merely thin surface rock scrapings. This stagnancy of the greater part of the glacier cap can hardly appear surprising, as the area ice-covered is small, the gradients are predominantly moderate, and the ice load can never have attained any great downward pressure except in a few favoured localities. The almost extinct glaciation of the north Platen Peninsula and the possibly still declining glaciation of the West Ice have thus very different characteristics from those generally associated with a retreating glaciation. These characteristics may prove not unlike those which were associated with the decline of the Quaternary glaciation in Finland.

It appears that the main function of the West Ice is protective, and that erosive effects are negligible. For the West Ice is essentially stagnant, its thickness not great, and the basic layers carry little morainic material. Moreover in the thicker parts of the glacier cap the lower levels are at 0° C. for the whole year as the winter cold wave only penetrates some 20–30 metres. Alternating freezing and thawing, and subglacial water may have some erosive power. Ahlmann has already stressed how little broken by young valleys are those parts of North East Land which are at present covered by ice, and with his view of the origin of the coastal plains and plateaux the evidence collected by the 1935–36 expedition is in accord. It would thus seem that the origin of the main land features of such an area as the Platen Peninsula occurred in pre-glacial times, but that a recent period of excessive ablation has left its trace in the river gorges.

Recent air photographs have shown that some corrections not included in the map reproduced, should be made to the north coast of North East Land, particularly around Dove Bay where there is a glacier not mapped.

(*To be continued*)

NOTES ON CRETE

SYLVIA BENTON

Meeting of the Society, 6 January 1941

THERE are several members of my School, the British School of Archaeology at Athens, who are better qualified to speak about Crete than I am, and I am only here to-night because they are serving their country elsewhere. I have travelled and lived in Crete and can tell about the ordinary life of the people. But of Crete I can claim no exhaustive knowledge, and have no store of original research to set before this society.

A word first about Greek names. One great difficulty for travellers and still more for soldiers in Greece is to understand and communicate Greek names. Names throughout this paper will be transliterated according to the P.C.G.N. rules for Greek. For instance, the capital often known by its Venetian name of Candia, will be called Iráklion with the stress marked: correct stress is more important than the quality of the sound. I use Attic forms, for Attic is understood everywhere. The Cretan dialect is only useful in Crete. The Cretan form is tchírie for kírie (sir) and khordjó for khorió (village). Tch and dj are Turkish sounds which the ordinary Greek cannot pronounce. It looks as if the Turkish occupation had had more penetration in Crete than elsewhere in Greece.

Another point about the names of Crete is that there is less difference between colloquial and official forms than in the rest of Greece. For instance, on the mainland, the junction of the Thívai (Thebes) and Kalkís railway is universally known as Skimatári, but written on the station as Oinóï, to the general confusion. Moreover, on the mainland, the government has only lately undertaken the expulsion of foreign names, in Crete it happened directly after the union.

Crete had great importance once, and she owed it partly to her geographical position; she was a convenient halting-place between Europe and Africa. She is still, as we know only too well.

Let us examine Crete as a stepping-stone to Europe. There are three big mountain masses whose peaks are snow-covered most of the year; snow-peaks near the sea are characteristic of Greek landscape. They are first the Aféndis in the east, with a Turkish name that has survived, the classical name Dicte is still heard; there is the Psiloríti range in the centre with the peak Ídhi (Mount Ida); and thirdly the Áspra Vouná in the west. In addition, the whole island is a mass of hills and rolling downlands, deeply seamed with rocky watercourses; and if ever there is a scrap of level ground it is covered with vines and olives. Vines are highly valued, and olives take fifteen years to bear. So it is not such a convenient stepping-stone after all. The Greek Government made an air port in the waste land east of Iráklion, and a regular service was in operation in 1939. It needed very little preparation except the removal of stones, and the few goats it nourished would not be missed. The surface is hard and pretty sandy, so that it would not get very muddy. I saw it

stand a good deal of traffic in wettish weather on Easter Day 1939, when the Greek barracks gave a dance. It is however completely exposed to the north wind coming romping in over the Cretan sea.

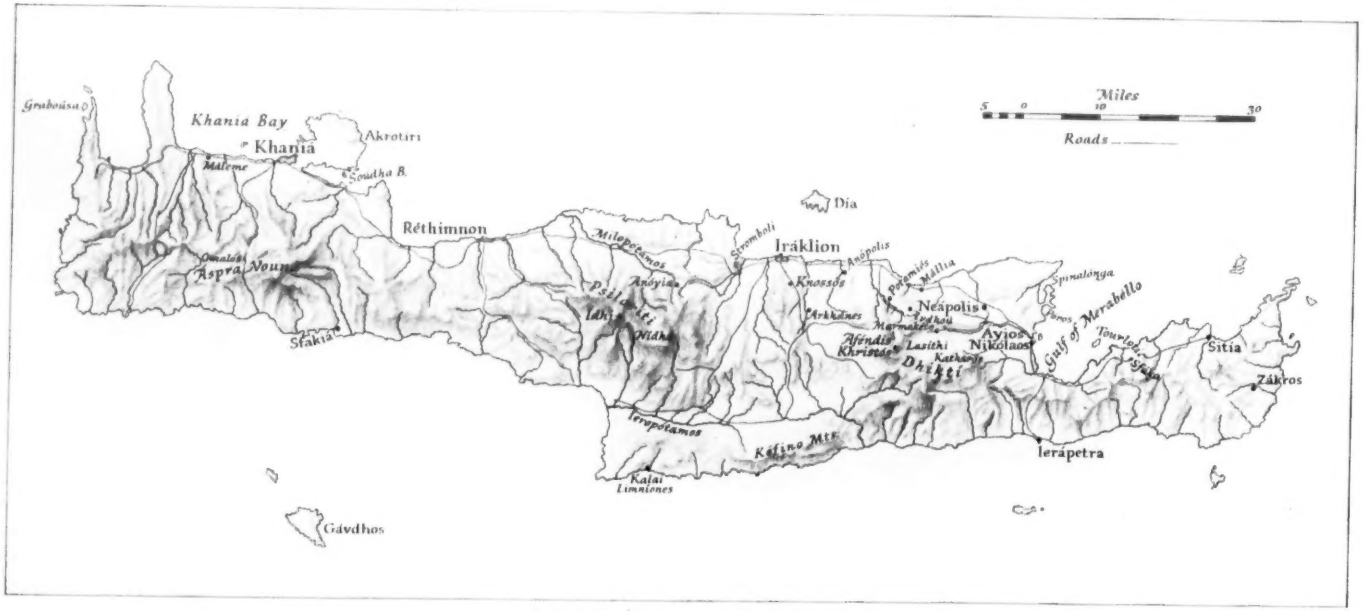
I rather fancy that a suitable corner for an air port could be found on the eastern part of the Gulf of Merabéllo before the hills rise steeply on the road to Sfáka. Farther east would not be so good because of the absurd break in the high road of $1\frac{1}{2}$ miles, between Sfáka and Tourlotí on the other side of the ravine. Unless indeed, the war has accomplished the impossible and joined up these loose ends, in the face of the vested interests of the local mule owners. An aerodrome on Merabéllo Bay would have the advantage of being able to use the harbour of Áyios Nikólaos.

A forced landing might be possible in summer on two mountain plains: on Nídha below the summit of Mount Ídhi (Plate 2), which is perfectly level but small and lonely, and airmen would have a bad time finding their way out of the mountains by evil tracks; and on the west end of the Lasíthi plain (Plate 1). The latter is bigger, but there are ditches and stone walls; still it is thickly populated, there are plenty of mules, a high road and even a motor bus. I am told that the plain on the west called Omalós (even) is extremely Anomalós (uneven), but an aerodrome of some sort appears to have been made at Máleme. A strategic site west of Soúvla was not available.

For its size and importance Crete is badly provided with harbours. In peace time steamers called three and four times a week at Khaniá and Réthimnon. There is not even a pier, they just lie and toss a long way from the port and passengers get wet and seasick in rowing boats. Boarding a Greek steamer is always an adventure: embarking passengers have to struggle on to and up a tottery gangway against a stream of descending traffic. The north wind is always blowing off Khaniá and Réthimnon, the boats toss and the steamer rolls; yet I have never seen any one pushed into the water. Réthimnon's minaret (Plate 3) gave an unusual note in a Greek town: on the mainland they have nearly all been destroyed long ago.

The struggle at Iráklion harbour should have been less fierce for the arms of the outer harbour give some protection, but the crowd used to be bigger and more excited. A few years ago the entrance was widened on the left, but even the outer harbour could hardly take battleships and the sea off the port was exposed. Hellenic travellers, who avoided harbour dues, could rarely land at Iráklion. The pointed hill behind is called Stromboli, evidently a Venetian name.

Once a week a steamer called at Áyios Nikólaos and Sitía. It came nearer the quay than at the other ports but, owing to vested interests, not right up to the quay. There was almost a revolution before the boatmen at the Piraiévs (Piraeus) allowed shipping to tie up to the quays, and about two years ago Pátrai (Patras) was similarly emancipated. Sitía had extensive quays and little traffic, and ships would find supplies in eastern Crete. At Áyios Nikólaos too there is more quay space than is needed for the local traffic, and it is a good centre for local produce including fruit and vegetables from the Lasíthi plain. I learn from a Handbook that Póros bay can shelter a squadron, and no doubt it was not left empty. Spinalónga was, before the war, the seaplane base of Imperial Airways (Plate 4).


Miles
5 0 10 30
Roads
Grabousa
Khania Bay
Akrotiri
Khania
Maleme
Soudha B.
Dia
Réthimnon
Iráklion
Milopotamos
Stromboli
Anopolis
Knossos
Arkhanes
Neapolis
Spinalónga
Gulf of Merabello
Ayios Nikolaos
Sitia
Zákros
Ierápetra
Aspra Nouna
Sfakia
Lasithi
Dhikti
Kafino Mt.
Kalai Limniones
Gávdhos

1. Plain of Lasithi and Dhikti range from the north

2. Mount Idhi from the north

Soúdha bay cannot be seen on the ordinary sea voyage along the north coast of Crete, and visitors by land were unpopular. The high road passes along it and there are two towns within easy reach.

Passenger steamers did not ply along the south coast of Crete, for nearly all the way the hills come sheer down into the water, so that there is little landward communication. Even at Messará, where there is a sandy beach, and Ierápetra, which is of some importance and has a small harbour, it is more profitable to take the produce by land to the north coast.

The prevalent wind in Crete is the north wind, Vorrás. It is also called by its Venetian name Tramontana, understandable in Venice but singularly inappropriate in Crete. Normally it blows every afternoon; it is refreshing in summer and keeps the Cretan sea rocking. It can rise to gale force, especially in the winter, but on the whole its office is benevolent, it turns the windmills along the north coast, and draws the water up all the long hot summer. Owing to Vorrás the Messará plain has quite a different climate from Knossós on the north side of the backbone. I crossed over one year in early April, when Knossós was still parched and shivering, like England, in an east wind: bright sun but not a hint of spring. In the moist Messará with its many streams, the air was balmy and the anemones were out. Later in the year the Messará becomes overpoweringly hot.

The wind that is feared by land and sea in the Aegean, and in west Greece too, is the south wind, Ostro, Auster of the storm in Virgil's Aeneid. On the sea it is gusty, very fierce, and very treacherous. There is a heavy lowering calm, and then it comes with a rush, and baffles about between south-east and south-west: when it has a good sea running, it backs and blows great guns from the north-west. When the Ostro blows the wise fisherman stays at home. Meanwhile the sky is full of minute irritating particles, so that if it rains the rain may be muddy. It burns the flesh on your bones, till you seem to be in a fever; it turns bread into toast; it shrivels the young vine shoots, or the young grapes, and leaves desolation behind it. Crete is much afflicted with this pestilential wind, and it is an additional reason against harbours or towns on the south coast.

Part of the fertility of the Messará valley is due to the protection afforded by the steep barrier of the Kófino mountains against the Ostro. During one of his excavations on the south coast, the late Sir Arthur Evans had his tents pitched on a flat beach, 6 feet above the sea. As the spring tide in August surprised Cæsar at Walmer, when he expected the Channel to behave like the tideless Mediterranean, just so did the Ostro surprise Sir Arthur, and he had to evacuate in darkness and confusion. Homer staged the shipwreck of part of Menelaos' fleet after the fall of Troy on a beetling headland on the south coast of Crete. Kalaí Limníones is said to be the site of St. Paul's shipwreck: it is a nice little haven when the Ostro is not blowing.

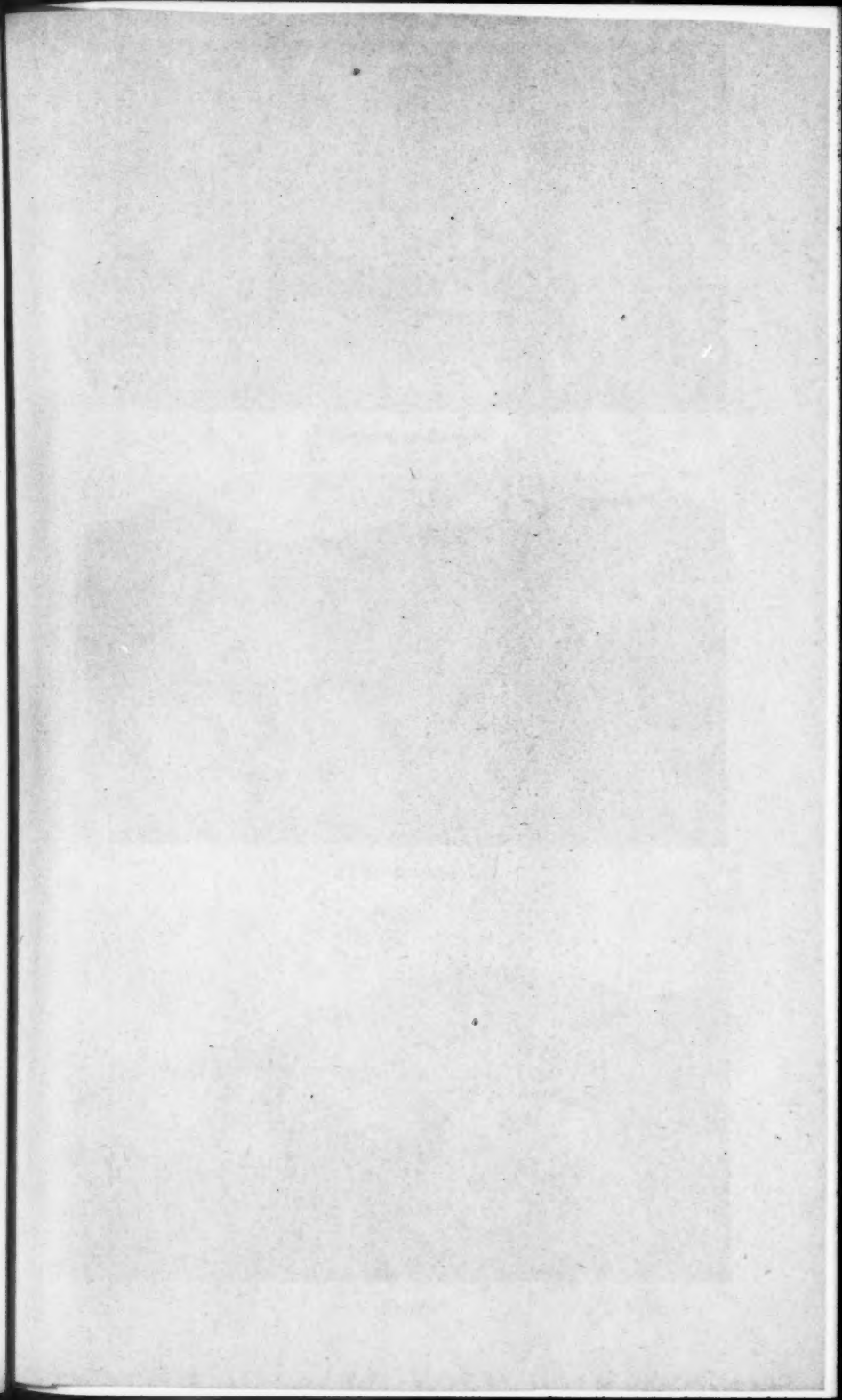
The question of fertility is bound up with the water question. The rainfall of Crete has decreased, and as deforestation proceeds it will decrease still further. They told me in Anóyia that there was a forest on the north slopes of Ídhi thirty years ago, and that a chance fire destroyed it. There are too many of these chance fires in Greece; there is an after-crop that goats like. I

am told that the southern slopes of the Áspra Vouná are still well wooded. There is an almost vertical ascent from Sfakiá to Anópolis, a small plain dotted with villages and well policed. Wood is collected from the mountains and the faggots go down to the sea by a zigzag track a little to the west; the trunks go over the cliffs into the sea. Here the Agrimi, the Cretan wild goats with long horns, still exist and are still hunted, though strictly protected. Once on the island of Día I came round a corner on a long-horned goat I must suppose to have been tame, but it went off like a stag or an arrow.

Another product of west Cretan mountains is outlaws, kléftes. Banditry is endemic in the Greek hills, and like piracy in Homer, a respectable profession. When a Greek commits an offence and feels disinclined for prison, he takes to the mountains, and may or may not prey on the inhabitants, none of whom will betray him.

Crete has a considerable rainfall. The *Pilot* gives Khaniá a mean yearly rainfall of 24·5 inches, and the mountains must have more. Great torrents dash down to the sea and are lost, for the rains are violent when they come. Hogarth has a graphic description of how the whole Zákros valley was devastated by a torrent (Plate 6); his camp was wrecked and he just escaped with his life. If some of this superfluous energy could be stored, as in the Marathon dam near Athens, Crete would be more fertile, though haply less charming. The rain all falls between November and March, leaving the plains almost rainless for the rest of the year. Nature does what it can for the Cretans underground, and millions of wells are pumped by the Cretan winds. A few of these can be seen on the Lasíthi plain (Plate 1). We spoke of this plain as a possible landing ground. It is flat enough, but rather heavily cultivated. Moreover, the Venetians or the Romans put a grid of drains over it. Windmills are all over the island, particularly near Mállia where the bananas grow. It is a pity the Greeks have not the patience to wait till they are ripe; grapes and melons, figs and oranges are allowed to ripen, but not bananas. Crete has particularly fine oranges. In east Crete there are no oranges, but dry waterless downs. When I walked over them in June, pretty good corn crops were being reaped. Suddenly we turned down a cleft into the Zákros valley, and there in June was a torrent shouting its way down along the village street. The sound was delicious after our long hot day, and I began to think of strawberries. There are no strawberries in Zákros, but they could be grown there if someone would make a high road, so that they could be sent to market.

The grapes and wines of Crete deserve a book to themselves. The big green grapes of the Knossós estate are memorable. Certain wines are on the heavy side but the vineyards of Iráklion produce a tolerable claret which the Curator declares is Malvoisy or Malmsey. There was a wine at Áyios Nikólaos, at the restaurant called *Τὸ Παλαιό*, the "Old Wine": it was mellow and golden and made waiting for the bus a pleasure. There is also Tsigoudhiá, a home-made spirit nicer than oúzo, and mouranó rakí (mulberry brandy), not to be had for money, only for love. The olive gathering is an annual picnic when the whole family turns out, often including the dog, the sheep, the goat, and the donkey. They hang their wallets on the trees, as they do on a famous red-figure vase, to keep them out of the dog's way. Not only little boys climb

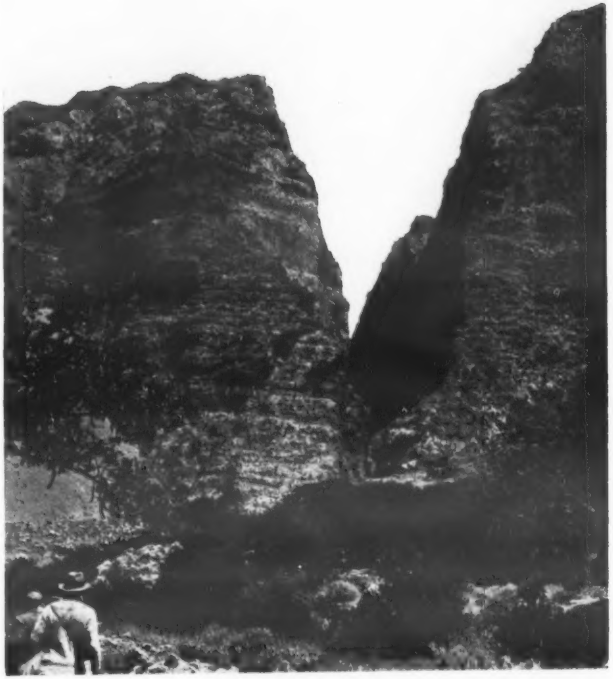


3. Rethimnon harbour

4. Spinalonga

5. Tripiti

6. Zakros gorge



7. Khaos gorge

6. *Zakros gorge*

7. *Khaos gorge*

the trees, I have seen old women up there. Olives must be gathered at exactly the right moment, and the whole tree does not always ripen at once. The family may have to go back and pick it over again. I should mention one other crop because it is modern. All along the road, between the olives near the sea and the oaks higher up, is a belt of Karob trees. A process has been discovered for manufacturing the finest photographic films from its beans.

Crete is famous for its flowers and April is the time to see them. All the bloom that lasts in England from March to October, in Greece has to be packed into two months April and May, and by the beginning of June everything is burnt up. There are finer anemones in Crete than anywhere in Greece, even finer than in Macedonia. The white are thick as corn in a cornfield in the valley above Knossós. A yellow anemone with a dark centre grows freely over the ruins of Gourniá. The Ieropótamos valley is a dream of flowery sweetness, sweet too the burn-side in the valley near Potamiés. Even when the thyme is not in bloom, aromatic scrub scents the wide eastern downs, and a tobacco field is overpowering in the evening, even on a poor field like one we had at Knossós.

A map which bears the date 1905 has a note that the roads are mere tracks, except in the vicinity of the three large towns. In 1939 there was quite a reasonable motor high road from Khaniá to Sfáka, then that absurd break, and another stretch from Tourlotí to Sitía. Some of it was excellent, some of it less good, but none of it really bad. One of the debts Greece owes to the Metaxás regime is a notable improvement in the state of the roads. Money voted for road making was actually spent on road making, not "eaten," as the Greek phrase has it, by the local authority. I first visited Knossós in 1926. The road from Iráklion was smothered in dust 4–6 inches deep. Dust or mud cars wallowed in and out of pot-holes like ships on a heavy sea. There was a tarred road later neatly lined with aloes. In the summer of 1939 I met a stretch of another road that reminded me of the old days. All went well from Iráklion to Potamiés, but the road from Potamiés to Avdhoú frightened me extremely. There seemed to be no road metal and the car lurched and slithered along the edge of a clear burn, with yellow pebbles. I couldn't see the anemones in the young spring green for watching the wheel skidding over the edge. The road was said to have been wrecked by lorries carrying potatoes. Potatoes do not do well in east Crete, it is too dry, and in west Crete they call them lordhikós, a lordly dish (only Lords can afford them). They grow well on the Lasíthi plain and are carried down on donkeys. There was an excellent high road and a regular bus service from Marmakéto on the Lasíthi plain to the main high road at Neápolis, but that would involve more petrol and still worse extra market dues.

The secondary roads running across the island are not too bad. There is one from Sitía to Ierápetra and from Áyios Nikólaos into the hills to Kritsá. A mule track connects with Katharós (the pure): high meadow land with pure air and pure water, a refuge from the fever-smitten plains of Iráklion in the summer, connected also by track with Lasíthi. There were good secondary roads past Knossós to Arkhánes and beyond: over the shoulder of Ídhi to Messará, and from Iráklion right into the hills towards Anóyia. The high

road goes over a fine mountain pass between Malliá and Neápolis. The western gorge is steep and narrow and would be easily blocked. The Milopótamos gorge is also good. I saw it full of oleanders in June, a harmony of grey rocks and pink blossoms.

If the roads of Crete were pretty good, the mule tracks are still abominable. There are two ways of walking them: to wear heavy boots and crash through everything till the boots wear out in a week or so, or to tread very light in something like the goat-skin shoes the shepherds wear. Light canvas shoes last about two months on this sort of track. Plate 9 shows a track, for the mules are on it. It cannot be too clearly stated that the paths on all Greek mountains are rather worse than the path up Ben Nevis. There may be smoother stretches but rough walking is a certainty. Therefore the Greeks do not walk on the mountains unless they must, they ride on donkeys or mules.

The donkeys are marvellous; without them Greek life would stop. The beast on Plate 10 is carrying olive clippings, but it might just as well be corn sheaves or brushwood. Plate 8 shows a gathering, a paníyiris. These beasts have brought their owners great distances to a church festival. According to the author of a learned paper on the Iliad that I heard last winter, all epics begin with religious meetings, meetings lead to brawls, and then some bard writes it up all wrong. I like to think that on Plate 8 we have the nucleus of a future Iliad. There must be few beasts in Crete now, for the Greek Government had for some time been collecting the beasts that made history in Ípiros.

To sum up this section on communications, Crete looks north to Greece, not south; roads, harbours, fertile lands are all on the north and not on the south. This is due largely to the two unchanging features of the lie of the land and the incidence of the malevolent south wind.

There is no word in the English language equivalent to Filóxenos. "Hospitable" is but a pale reflection. The Cretans really do love strangers. They have active minds which are not sufficiently exercised; they suffer from chronic boredom and the coming of a stranger is a real delight. Besides there has been a cult of the English since the time of Byron, and a fresh tradition sprang up from the fire at Thessaloníki (Salonica). Inglésa imi (I am English) and they smile all over their faces. The Curator of Knossós and I arrived at Zákros in east Crete one summer evening. He said to me, "The schoolmaster here is a delightful person, but we'll go to the kafeníon. Then he needn't ask us to stay unless he likes." We stood by the door and greeted. At once a table was cleared for us, glasses of Tsigoudhiá were poured out for us, and refilled the instant they were empty, at the expense of complete strangers, who were much too poor to dream of ordering drinks on that scale for themselves. The schoolmaster hurried up, indignant that we had not gone straight to his house. His good wife immediately brought more drinks, and then set to preparing a large meal for us with every appearance of delight.

The Cretans are a gay people, fond of dancing to gay tunes, which are vaguely reminiscent of Scotch airs, but the rhythm breaks in a way that is baffling to Scottish ears. Some of the steps too are a little like Scotch turns. The gentleman on the left in Plate 11 is pointing his toes beautifully. Note his high Cretan boots, a fashion that descends in Crete from Minoan times.

8. A paniyiris

9. A mule track

10. A loaded donkey

11. Dancing on Mount Karfi

They are said to be required by Cretan thorns, but thorns in Crete are no worse than thorns in other parts of Greece, in Itháki, for instance. The boots too are often of fine soft leather, a sort of dress shoe quite unsuitable for mountain paths.

The Cretan is jovial enough in the home circle, but abroad he wears a tremendous dignity. He really thinks he is worth two of any other kind of islander. The curious thing is that the other islanders think so too. I have watched the progress of our Cretan foreman, Giánni Katsarákis, in Itháki for ten years. He never raised his voice, he never had to; and soon in all questions of dig-bargaining it was, "Ask Maístro Giánni, he knows what is right. He is an upright man." In ten years I have not known his accounts one drákhma out, nor heard one crooked statement.

The struggle against the Turk was long and bitter, but the bitterness is dying out. Now the Turk is forgotten, all but a few old tales: one of how Christians were smoked out, in the cave at Psikhró above the Lasíthi plain, and another about the eponymous gun at the monastery of Toplou.

Cretan men are decorative. Their costume is superb, blue or black, sometimes slashed with red and set off with white. The partial covering of the face is a relic of the Turkish occupation, but even the men hate it when the sun spoils their beauty:

Μοῦ δέρνει ὁ ἥλιος καὶ ὁ Βορράς
Καὶ πῶς νὰ μὴ μαυρήσω

(Sun and north wind beat upon me, how shall I not turn black) "Hideous," they say, "and my wife won't love me."

DISCUSSION

Before the paper the PRESIDENT (Field-Marshal Sir PHILIP CHETWODE) said: I have to introduce to you this afternoon Miss Sylvia Benton, who is to speak to us on Crete. Miss Benton has spent twelve years in Greece on archaeological investigation for the British School of Archaeology in Athens. She has travelled and worked in most parts of Greece, particularly in the Ionian Islands and the islands of the Aegean. This afternoon however Miss Benton will not deal with archaeological problems but with the people of Crete and their island life.

Miss Benton then delivered the lecture of which parts are printed above, and a discussion followed. Events in Crete since the lecture was delivered have for the present so much changed the aspect of affairs that some of the paper and much of the discussion have in the interval become inappropriate for publication.

Brigadier-General Sir PERCY SYKES: The horses of the Parthenon frieze are of a distinct type. During many visits to Greece I looked in vain for one of those little horses until one day I saw one in Crete, very near Sir Arthur Evans' excavations, and I wonder whether the lecturer has seen any Parthenon horses anywhere else in Crete.

Miss BENTON: I think I have. Crete is famous for its horses and they are much used on the island. I am not learned in horse lore, and do not know the name of the breed now used, but they certainly are rather like the Parthenon horse.

The PRESIDENT expressed his pleasure that Miss Benton had spoken at some length on the strategic aspect of Crete and had remarked upon suitable sites for additional aerodromes. He asked the meeting to give the lecturer their thanks for a most interesting paper.

NEW WORK ON THE GULF STREAM

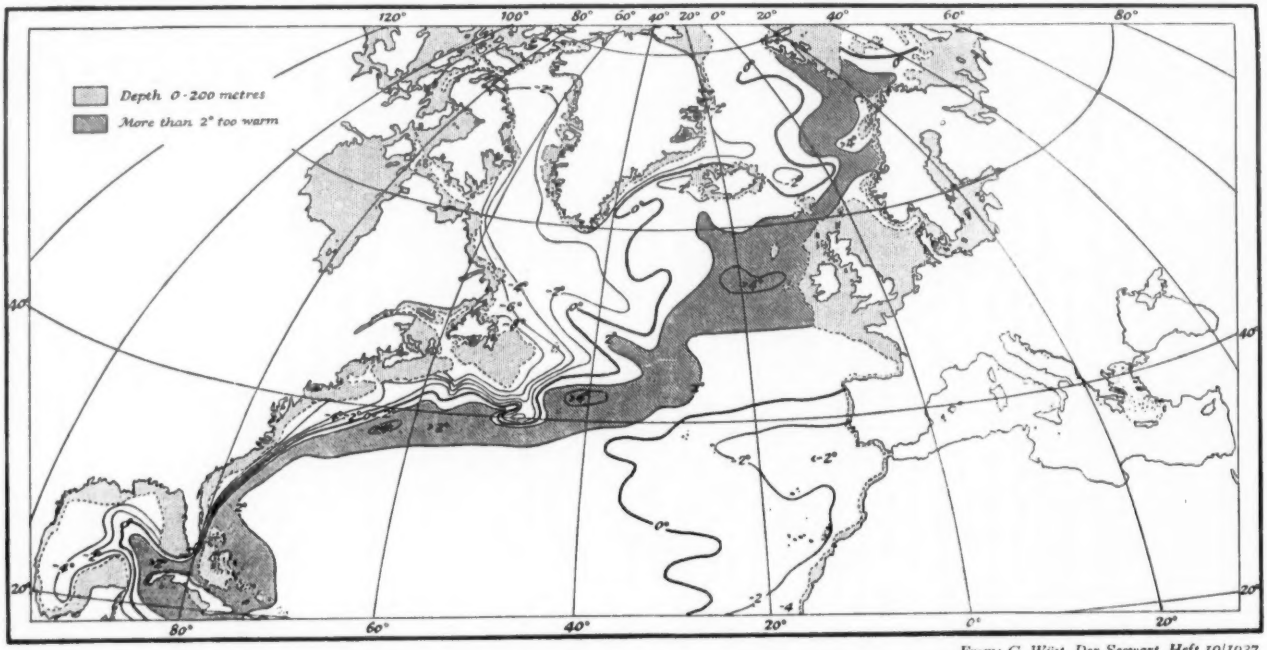
G. E. R. DEACON

REPORTS published during the past ten years, mainly by Iselin and others in the United States, have built up an almost new conception of the Gulf Stream, and the latest paper by Iselin gives long-sought information about the short and long period changes in the current which have always been supposed to be capable of changing the water conditions off the coasts of north-west Europe.

The Gulf Stream has been shown to be a continuation of the North Equatorial Current and the trade-wind drifts, and part of an anticyclonic current system which covers the greater part of the North Atlantic Ocean; the water carried by the North Equatorial Current begins to turn northwards as it approaches the American coast, some inside the Carribean Sea and the remainder between the West Indies and Cape Hatteras. It has been estimated that the proportion entering the Carribean Sea is about two-fifths (Iselin, 1936); it curves from west to north, and after sending a small branch round the deeper part of the Gulf of Mexico, returns to the open ocean through the Straits of Florida. It is there that great speed is such a feature of the current: the straits appear to act as a funnel through which the water pours at an average speed of 3 knots and sometimes as fast as 5 knots.

As it emerges from the Straits of Florida the current is joined by the Antilles Current which follows the curve of the West Indian islands outside the Carribean Sea; but recent observations show that the Antilles Current is not much stronger than the general westerly movement of the North Equatorial Current, and as far as can be seen at present the current from the straits is not suddenly augmented but shows a steady increase. During the period of growth it presses close to the land, flowing along a broad coastal plateau with soundings for the most part less than 1000 metres; it begins to enter deep oceanic soundings just south of Cape Hatteras, and is then joined by a movement of deep water along the continental slope.

It is in the next section of its path, between Cape Hatteras and Nova Scotia, that the current reaches its full development. Its surface speed falls to an average of about 2 knots, but its volume increases till it carries three times as much water as the current through the Straits of Florida; its width is approximately 130 miles and movement can be traced to a depth of about 1500 metres. Iselin has estimated the water transport to be 80 million cubic metres a second, seven hundred times as much as the greatest flow of the river Mississippi. The current does not hold to the land after it enters the deep water, but begins to draw away from the continental slope, becoming separated from it by a widening region of mixed water, some 60 miles wide off Chesapeake Bay, north of Cape Hatteras, and 170 miles south of Nova Scotia. On the continental shelf there is coastal water of low salinity and large seasonal temperature changes which contains the drainage from the land and the last traces of the Labrador Current, and between the Gulf Stream and the shelf, a mixture of Gulf Stream and coastal waters which has only weak and irregular move-



From: G. Wüst, Der Seewart, Heft 10/1937

Temperature differences of the Gulf Stream system at a depth of 200 metres

ments. On the other side of the Gulf Stream, to the eastward, is found the warm, slow-moving water of the Sargasso Sea.

Where enough deep-water observations are available to form the basis of a vertical section across the ocean, the presence or absence of movement can be decided from the slope of the surfaces of equal density, or, with good approximation in the Gulf Stream system, from the slope of the isotherms; the slope is a direct consequence of the effect of the earth's rotation on the water movement, and in the northern hemisphere the density surfaces slope downwards to the right. In the Gulf Stream region the isotherms are roughly horizontal to the west of the current and in the Sargasso Sea, but they slope from west to east in the fast-moving current itself. The current occupies a transition region between the cold water near the continental slope and the warm water of the Sargasso Sea, and it is only in the upper 200 metres that it is warmer than the water on both sides. This new conception of the Gulf Stream as a boundary feature is given much prominence in the recent reports, and it is pointed out that there is little justification for the old idea that the current resembles a warm river flowing through colder seas.

The next important change in the Gulf Stream takes place as it curves towards the east south of Nova Scotia; it begins to broaden out as more and more water eddies from both sides, and east of the Newfoundland Banks it appears to divide into three branches. The chief branch crosses the ocean to north-west Europe, the second is directed towards the Portuguese coast, and the third returns towards the south-western part of the Sargasso Sea. Till more observations have been made only the northern branch can be followed with any certainty; it is very different from the Gulf Stream between Cape Hatteras and Nova Scotia, being hardly strong enough to show as a continuous movement on an ordinary chart of surface currents—not faster than 2–5 miles a day and varying largely with the wind; in 30° W. it is 10° C. colder than the Gulf Stream south of Nova Scotia, and shows dilution with water of northern origin—with the cold water of the Labrador Current at the surface, and with Arctic intermediate water, from a current which is similar to, though much weaker than the well-known Antarctic intermediate current, below about 300 metres.

The path of the weakened current is most easily followed with the help of a temperature chart, and some advantage is gained by using one for a subsurface stratum where the short and long period changes are smaller, and the chart can be based on more numerous data because observations made at any time of the year are comparable and can be combined in one chart. One of the most useful charts published so far is one which Wüst (1937) has made for a depth of 200 metres by plotting the temperature difference by which each small area bounded by $2\frac{1}{2}$ degrees of latitude and longitude is warmer or colder than the mean for the same latitude interval across the whole width of the ocean. The 200-metre level was chosen partly because a slightly higher salinity indicates that the current may be strongest and least variable at that depth. It must however be remembered that the water at 200 metres is generally colder than the surface water, so that the positive temperature differences on the chart do not only show the northward movement of warm water but also the dipping of the isotherms in the right flank of the current

caused by the effect of the earth's rotation; taking these facts into consideration the chart gives reliable evidence of a continuous current from the Newfoundland region to the Faroe–Shetland channel and then to the north of Norway and Spitsbergen. Except in the region west of Ireland and in its approach to the Arctic Ocean the current appears to be concentrated in a strikingly narrow band, and this appears to mark a boundary region between warm highly saline water to the south-east and cold poorly saline water to the north-west, though the difference is much smaller and less sharp than it is between the warm and cold waters off the American coast. Fluctuations in the position of such a boundary would be likely to change the conditions in the European coastal waters, and measurements in the North Atlantic Ocean by Le Danois (1934) may be more useful if such an interpretation, less extravagant than his own, is put upon them.

Much of the recent work on the Gulf Stream has been planned to measure seasonal and annual changes in the volume of water and amount of heat that is carried by the current, and the Woods Hole Oceanographic Institution has been cooperating with the Bermuda Biological Station, supported by the Royal Society, in a five-year programme of observations on the current between the Straits of Florida and Nova Scotia. It is of the first part of this work that Iselin has made a preliminary report (1940).

Owing to practical difficulties direct measurement of the speed of a deep-water current cannot yet be made on a large scale, and the method generally adopted is to estimate the volume of the water transport from the slope of the density surfaces in the current relative to some deep surface which is supposed to be level because the water at that depth is likely to be motionless. This method involves the making of a great many deep-sea observations, and the Gulf Stream measurements would take the whole time of a large and expensive research vessel, so that efforts were made to find a cheaper method. At first it was thought that the slope of the density surfaces could be decided from observations at only two points, one on each side of the current, but it was found that the path of the current fluctuated more than had been supposed and also that the density surfaces near the edge of the current were often displaced vertically by powerful eddies; a fixed point near the edge of the current would be suitably placed on one occasion, but would be too far inside or outside the current when the current had moved to the left or right; the only way to find the edge of the current and to detect large eddies was to adopt the old procedure of making a vertical section with as many observations as possible.

Another method which promises to be more useful (Montgomery, 1938; Iselin, 1940) is to base the calculations of water transport on the slope of the sea surface, using monthly figures for mean sea-level obtained from tide-gauge measurements on both sides of the current. This slope, like that of the density surfaces, is a measure of the effect of the earth's rotation and proportional to the speed of the current. It is difficult to make allowance for factors such as changes of wind, atmospheric pressure, water temperature, and inflow of fresh water which may alter the slope without a corresponding change in the current, but they are not likely to lead to serious error in the Straits of Florida. The most direct information is obtained by comparing the records

from Miami Beach, Florida, with those from a gauge specially erected at Cat Cay, a small island almost directly across the current; other figures have been obtained from the records of longer established stations at Charleston and Bermuda; the average difference in level across the Straits of Florida is about 55 centimetres.

Iselin shows that for the last few years the calculations based on tide-gauge records give results in good agreement with those obtained by the more fundamental use of the density surfaces; the work must be continued for some time before definite conclusions can be reached, but it is fairly certain that the Gulf Stream is usually strongest in July or August and weakest in November, the difference between the two extremes being about 20%. The tide-gauge measurements show a secondary strong period in March, when little is known of the density distribution. Information about the long-period changes is derived almost entirely from the tide-gauge measurements; so far as can be seen at present the fluctuations from year to year are slightly less than the seasonal changes, and in order of decreasing water transport the years 1932–1937 follow in the order 1934, 1932, 1938, 1933, 1936, 1935, 1937.

When considering the seasonal and annual changes in the current it is important to note that the Gulf Stream water is often carried beyond the usual limits of the current by powerful eddy movements sometimes 60–80 miles across; they are most conspicuous to the left of the current, especially in the neighbourhood of Nova Scotia, where the current is farthest offshore and the contrast between the coastal and Gulf Stream waters is greatest. When the eddies are closely examined they are found to consist of a shallow core of Gulf Stream water whose temperature and salinity are gradually being reduced by mixing with the surrounding water. A new instrument, the Bathythermograph, has been designed to make rapid observations across such mixed water regions (Spilhaus, 1940). It can be lowered and raised very quickly from a moving ship and gives a continuous record of the variation of temperature with depth down to 150 metres; a further modification, not yet perfect, will also take water samples at six specified depths. The temperature measurements made with the instrument are not so accurate as those obtained with deep-sea thermometers, but if they are made every few miles a much more accurate picture of the temperature distribution can be obtained from them than from more precise measurements spaced at much wider intervals. Used in conjunction with the older methods the bathythermograph must soon have wide application; it will reveal eddy movements, internal waves, and other irregularities whose existence would otherwise not be suspected and will prevent false interpretation of data affected by such disturbances. Other rapid temperature-measuring instruments have been made in Norway and France, but that of Spilhaus has so far been the most useful.

The temporary migrations of the Gulf Stream water have been studied by Hachey of the Canadian Fisheries Research Board, using continuous records of surface temperature obtained by ships running between Nova Scotia and Bermuda (1940). He has compared his results with the tide-gauge measurements and finds that the northern limit of the Gulf Stream water tends to be far north and variable when the current through the Straits of Florida is weak, and far south and steady when the current is strong. This may partly be due

to the greater effect of the earth's rotation on the stronger current which would tend to make it turn more sharply to the east, but changes in other water movements and winds may also have an important effect. The reports of Iselin and Hachey show that both the Canadian and American coastal waters are warmer when the current through the Straits of Florida is weak and colder when it is strong.

There is not much precise information about the effect of the fluctuation of the Gulf Stream on the waters of north-west Europe though Tait (1939) and Helland-Hansen (1934) have evidence of variation of 20–30% in the northward movement in the Faroe–Shetland channel and off the northern part of the Norwegian coast. A greater degree of international cooperation to obtain adequate data was reached in 1938, but there has not been time for much to be done. The Gulf Stream subcommittee of the oceanographical section of the International Union for Geodesy and Geophysics have agreed to carry out intensive work over small areas, making the study of the irregularities and fluctuations which such work reveals their first consideration (Helland-Hansen, 1939). The progress of the work off the American coast directs attention towards the possibilities of suitably placed tide-gauges and continuous records of surface temperature along regular shipping routes; and shows that good use must also be made of an instrument such as the bathythermograph.

The progress of the work on the Gulf Stream has brought a number of new names into common use: most writers have felt the need of specific names for certain sections of the current, and it has been agreed to use "Florida Current" off the coast of Florida, and "Gulf Stream" for the fully developed current between Cape Hatteras and Nova Scotia. The movement from the Newfoundland region to the Faroe–Shetland channel is usually known as the North Atlantic Current; and, making a distinction between the variable winddrifts at the surface and the steadier movement not entirely due to wind in the subsurface layer, the prevailing drift at the surface is often called the North Atlantic Drift. In Norway and Germany the name Norwegian Current is used for the current along the Norwegian coast. The whole current system from the Carribean Sea to the Arctic Ocean is known as the Gulf Stream System. It will seem a pity to most people that "Gulf Stream" cannot be used to make a general reference to any part of the current. The lack of something between the specific names for small sections and the comprehensive name for the whole system has led to such awkward expressions as "north of Cape Hatteras the Gulf Stream System reaches its full development" and "the Gulf Stream System flows northwards from Miami towards Cape Hatteras." Both Wüst and Iselin would have avoided the use of the name Gulf Stream altogether if it had been possible; Wüst because the current does not originate from the Gulf of Mexico, and Iselin because the name is so much associated with the idea that the current resembles a warm river flowing through colder seas.

Iselin promises a more complete review of the recent observations made by the Woods Hole research vessel *Atlantis* before long; he has done more than anyone to arouse enough interest to get an adequate number of observations made, and it is hoped that he will be able to continue.

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THE DISCOVERY OF TORRES STRAIT

IN 1928 Messrs. Sotheby sold a collection of Spanish manuscripts, the property of the late Sir Thomas Phillipps, and Messrs. Henry Stevens, Son and Stiles acquired several volumes of miscellaneous papers, one of which was found to contain a '*Relación sumaria* of the discovery begun by Pero Fernandez de Quiros . . . and completed for him by Captain Don Diego de Prado . . . with the help of Captain Luis Baes de Torres . . . up to the City of Manila.' This title immediately attracted the attention of Messrs. Stevens and Stiles, for a document in Prado's handwriting, which began by claiming that he himself was responsible for completing the discovery, with the help of Torres, might be a find of the first importance.

Prado had sailed from Callao in December 1605 in Quiros' ship, the *San Pedro y San Pablo*, with Torres' ship, the *San Pedrico*, in company. At some time before the expedition arrived at the island of Espiritu Santo, Prado and the chief pilot Ochoa had left the flagship and gone over to Torres' ship. At Espiritu Santo, for reasons which have been much discussed, Quiros and his ship sailed away to Acapulco, leaving Torres to continue the voyage of exploration to the south and thence to the rendezvous at Manila appointed in the Viceroy's instructions. On this voyage Torres passed through the straits which now bear his name, proving that New Guinea is separated from Australia.

When Sir Clements Markham edited for the Hakluyt Society 'The voyages of Quiros,' published in 1904, the authorities for this latter voyage were a letter of Torres to the King written from Manila on 12 July 1607; two letters of Prado written from Goa, to the Secretary, Antonio de Arostegui, on 24 December 1613 and to the King on the following day; and four maps preserved at Simancas, with legends describing them as the work of Captain Don Diego de Prado y Tovar, one of them with his rubric. The first is of a harbour in Espiritu Santo; the other three are of harbours in New Guinea. A general map of the discovery mentioned in the letter of Prado to the Secretary has not survived.

Markham has no good to say of Prado: he was one of the three who "stirred up mutiny and disaffection on board"; he was "another mutinous officer"; yet "there was not a single instance of capital punishment during the expedition"; he was perhaps the draughtsman of the maps which bear his name and rubric, but the surveys were no doubt made by Torres himself, or by his chief pilot, Fuentiduenas. Markham's chapter on them has "Maps of Torres" for the running title.

Torres in the letter of 1607 describes Quiros as the Commander (*Cabo*) and himself as his *Almirante*; he does not name Prado. Prado in his letter to the Secretary describes Torres as Captain of the *Almiranta* of Quiros, and himself as going as Captain of the *Capitana* but as disembarking at Taumaco and transferring to Torres' ship. In the letter to the King Prado describes Torres as the Admiral of Quiros, and makes no mention of his own position.

Until 1930, then, the historical repute of Prado was not high. He was accounted an insubordinate if not disloyal officer; and indeed there are

passages in Prado's letter to the King which give some support to this opinion. The newly discovered *Relación* put things in a very different light. The manuscript was acquired by Sir Leicester Harmsworth, who consented to its publication by the Hakluyt Society under the editorship of Mr. Henry N. Stevens, with a new translation by Mr. G. F. Barwick.[1]

In reading the *Relación* it is important to remember that the ship of the leader was called the *Capitana* and the second ship the *Almiranta*. In the first sentence, Quiros is called the Captain and Commander (*capitan y cavo*). A few lines later we find that in the *Capitana*, the *San Pedro y San Pablo*, were the commander (*cavo*) Quiros, the captain (*capitan*) Prado, the chief pilot, master, accountant, three Franciscan fathers, and sixty sailors. But whether Prado is truthful in calling himself captain of the ship is doubtful. Torres was *capitan* of the second ship, but in the narrative is sometimes referred to as *almirante* to Quiros. After Quiros had disappeared from the scene, Torres was called *capitan y cavo*, as on the maps in Prado's own writing, which are at Simancas, and which were probably four of the five maps mentioned by Torres in his letter from Manila of 1607. In the narratives of Quiros and several of his staff, published by Markham, there is only very slight mention of Prado and he is not mentioned by Torres in his letter from Manila of 1607. In Prado's *Relación*, of which the surviving version must be later than 1614, we read on page 113 that "Captain Don Diego de Prado knowing for certain that the crew of the *Capitana* were going to mutiny informed the said Quiros by way of confession through the Father Commissary of the Franciscans, who told the said Don Diego that he also knew it and had informed him and would do so again, but the said Quiros took no notice of it; so the said Don Diego, seeing the little remedy that was to be expected, asked leave of the said Quiros to pass to the *Almiranta* with his rations, which were the same as those of the said Quiros; he granted it to get rid of the bother, and Don Alonso de Sotomayor went in his place. The said Don Diego knew who were the mutineers and how they wanted him for head, but he did not want to mix in such conflicts and lose the honour which he had gained in the service of his Majesty, so he at once shifted his things to the *Almiranta*, whereat the Captain thereof was very pleased." Is it credible that if Prado was *capitan* of Quiros' ship, he would have taken his position so lightly as to ask leave of his chief to transfer to the other ship, instead of standing by his chief and facing the mutineers? Is not his conduct more consistent with that of a gentleman adventurer sailing in a position rather indeterminate? Remembering that Prado is nowhere called captain except by himself, and first in his letters from Goa of 1613, it seems reasonable to treat with reserve his statement in the *Relación*, that when Quiros and his ship had left the others, the sealed orders from the Viceroy of Peru, which Torres produced, made Prado chief of the expedition; that he accepted the charge as committed to him, and thenceforth executed this office. Markham was perhaps wrong in treating Prado as an insubordinate and mutinous officer. The rôle of gentleman adventurer seems to fit the story better.

[1] We are informed by Messrs. Henry Stevens, Son and Stiles, that the manuscript of the *Relación* is now the property of the Mitchell Library, Sydney, N.S.W.

Prado gives the crew of the *Capitana* as sixty sailors, of the *Almiranta* forty, and of the launch twelve. Quiros (Markham, pp. 179 and 181) says that in all there were embarked nearly three hundred men, sailors and soldiers; that they had received pay in advance; that when the inspection was made there was not a man missing who had received pay, "and not counting those there were twenty-two." One may suppose that most of these were gentlemen whose names figure later in the strange proceedings at Espiritu Santo: the appointment of Royal officers and of a Municipality for the prospective city of the New Jerusalem; the establishment of an order of knighthood. The two lists, of Quiros–Bermudez and of de Leza, are printed in Markham's Quiros, and suggest that Prado was one of many gentlemen adventurers on the expedition.

When they sailed from Callao on 21 December 1605, Quiros hoisted his standard as soon as he had got out of sight of the Viceroy, who had forbidden him to do it because he was not a general, and Prado hoisted his flag which bore the cross of Calatrava. Stevens, on the strength of heraldic and genealogical researches which he does not further specify, says that Prado was a knight of Calatrava, one of the oldest and most distinguished of Spanish orders of chivalry, and that he belonged to one of the noblest families of Madrid. Except for the reference to his standard, there is no further indication of his standing until after his return from Goa he became a monk of the order of St. Basil the Great of Madrid and so describes himself in the introductory paragraph to the *Relación*. These words in the introduction "now a monk of our father St. Basil the Great" seem to show that the manuscript which came into the hands of Mr. Stevens was written after 1614, for the arrangement of the first page, reproduced in facsimile, makes it clear that this introductory paragraph was not a later endorsement, but was its preface, inset as a kind of explanatory title. The *Relación* ends with a certificate signed by Torres, described as Captain, by the master, the chief pilot Ochoa, and the notary, "At the instance of the Captain and Commander Don Diego de Prado, that they have seen this account and it is accurate and true," and they signed it at Manila on 6 June 1608, a year after they reached that port. The rubric following Prado's signature at the end of the *Relación* is the same as that on Map IV, and one may accept the opinion of Stevens that the *Relación* and the four maps are in the same hand, presumably Prado's. So of course are the signatures of the witnesses to the certificate in the copy annexed to the *Relación*.

In his editorial introduction to the *Relación* and its translation by Barwick Mr. Stevens has discussed the probable route of the ship, accepting Markham's identifications of the three ports which were mapped, two at the eastern extremity of New Guinea and one at the western; but he does not go with any detail into the interpretation of the difficult intermediate parts of the narrative, and in the sketch-map which he publishes to illustrate the passage of the strait he takes the ship down on a course from the Aird River Delta, keeping east of the Warrior Reef, passing through Endeavour Strait, and thence direct to False Cape.

In a paper published by the Royal Australian Historical Society in 1930 Commander Bayldon of the Sydney Nautical School has severely criticized this interpretation. Much depends upon the accuracy of the figures in Prado's narrative. There are places where it is doubtful whether he is talking of degrees or fathoms, but there are others in which latitude is explicitly given and very difficult to reconcile with the narrative. It becomes then of some importance to have independent testimony to the numerical accuracy of Prado, and he has fortunately provided it himself by accounts of two total eclipses of the moon and of certain observations of objects of the southern sky, which seem to be the two Magellanic Clouds and the dark gap in the southern Milky Way which bears the graphic but ugly name of the Coalsack.

Of the first eclipse of the moon Prado says: "On the 22nd March the moon was eclipsed to a red colour approaching black, it began at 8 o'clock at night and ended at 3 in the morning." This was in the earlier part of the voyage before Prado had left the *Capitana* of Quiros, and there is an independent account of the event in the journal of the chief pilot Leza (Markham, 'Voyages of Quiros,' vol. II, p. 351), who says, under date March 23: "At 8 o'clock in the evening an eclipse of the moon began, being 37° above the horizon, and ended at an altitude of 52° 30′. It was a total eclipse the colour of mourning, beginning to eclipse on the S.E. side and to clear on the E. The eclipse lasted two hours and a half." According to Oppolzer ('Canon der Finsternisse,' Vienna, 1887), the time of mid-eclipse on 24 March 1606 was $10^h\ 21^m$ Greenwich Civil Time, which as the ship was in longitude about 180° W. and coming from a western port, would correspond with March 23 $22^h\ 21^m$ local time. The whole duration of the eclipse was three hours thirty-eight minutes. Prado says it was seven hours; Leza says it was two hours and a half, which is very close to the time from the beginning of the partial phase to the end of totality. The beginning of the partial phase was on March 23 at 20.32 and the end on March 24 at 00.10 in the time of the 180th meridian. Leza says it began at eight on March 23 and Prado at eight on March 22. Leza is right on the day and approximately on the time, and the length he gives for the duration is explicable as above. Prado was a day wrong in the date and his duration of the eclipse nearly twice the true duration.

Prado describes another total eclipse of the moon on September 22, of which he says: "On the 22nd September there was another eclipse of the moon as great as that of March, of the same colour, but it lasted an hour longer." Commander Bayldon first pointed out (Royal Australian Historical Society, *Journal* XVIII, Pt. I, 1932) that the date must be wrong. The same eclipse is described in Bermudez's narrative of Quiros' return voyage (Zaragoza, and Markham I, p. 289). Markham translates the date September 26, but Mr. W. Dixson has pointed out that Bermudez says "diez y seis di septembre," that is September 16. Oppolzer gives the time of mid-eclipse as September 16, $11^h\ 54^m$ Greenwich Civil Time, which for Prado in longitude 218° W. and keeping the western date would be September 15, $21^h\ 22^m$. For Quiros, in longitude about 141° W., it would be September 16, $02^h\ 30^m$. Bermudez says that it began at three hours in the morning of the 16th and lasted three hours: the true duration being three hours forty-two minutes, from Oppolzer. Prado says that the eclipse was on September 22 and that it lasted an hour longer

than that of March 22, that is, it lasted eight hours. He is therefore seven days wrong in the date and more than four hours wrong in the duration.

There is thus fortunately no difficulty in saying that Prado's account is very inaccurate compared with the standards of the time. The two independent accounts are tolerably correct; Prado's are both seriously wrong.

Consider now his account of what was seen a fortnight after they left Callao, that is to say about January 4, when "they took the sun with the astrolabes and found they were in sixteen degrees of south altitude. That night as it was very clear we saw in the sky three clouds, each in the form of an altar-cloth, but much larger, two were white and the other black as pitch smoke, in the north-north-east quarter, the first was white like the Milky Way which in Castile they call S. James's Way, and seemed full of very brilliant stars; the altitude was taken with the cross-staff and it was found to be 30° above the horizon, some said that that [altitude] is over the hill of Potosi; the other was black and much larger and diverted towards the north, also full of stars, and this was 40° above the horizon; the other was white and much larger and higher than the others, in the direction of the black one, in 55° above the horizon; these were seen from the ships for the space of two months." There can hardly be much doubt that the two white clouds were the two described by Pigafetta and long known as the Magellanic Clouds. The first known account of the greater cloud, by Pietro of Abano, says if I remember aright, "In the country of the Zinghi there is a star as big as a sack." To the more reverent Spaniards it suggested an altar-cloth. These objects lie about the southern pole roughly 20° from it; the Coalsack and the smaller cloud on opposite sides; the greater cloud roughly half-way round from one to the other. Prado says that the smaller cloud was found to be 30° above the horizon, which is possible. In that latitude it would have reached its maximum altitude of 33° very early in the evening. The black cloud is described as 40° above the horizon, and it might be that about five o'clock in the morning. The larger white cloud was said to be 55° above the horizon, which is impossible. The maximum altitude of its centre in that latitude is and was in 1606 about 36°. All three are described as being in the N.N.E. quarter, which is quite impossible. The smaller and the black one are described as full of brilliant stars, which is hardly correct though the latter is surrounded by very brilliant stars, two of the Cross, and the two bright stars of Centaurus.

We may conclude then that these observations apply to the clouds of Magellan and the Coalsack; that they are fairly good in description but wrong in the figures given; and if we add this testimony to that of the eclipses, we are bound to say that when Prado's figures can be tested, they are found to be wrong, and that therefore it is not much use in argument to rely upon the exactness of his latitudes or dates.

Nevertheless, Prado's *Relación* is by far the most important document for the voyage of Torres and the discovery of the strait which since the time of Dalrymple has borne his name. The narrative from the first sight of New Guinea to the rounding of False Cape takes sixteen pages of Mr. Barwick's translation. For this part of the voyage Torres' letter has only one page; there are the three maps by Prado of New Guinea harbours; and practically

nothing else. Prado seems to have been a man of good education; he wrote rather well, and he made creditable sketches of at any rate two of the three places which he tried to map. He was perhaps more of a soldier than a sailor, and better at topography than at figures; we need not now follow Markham in his suggestion that the maps which Prado signed were really made by Torres. And some of the obscurities in the more technical parts of the narrative may not be Prado's but his translator's.

The translation of the *Relación* was undertaken by Mr. Barwick, and one may be allowed to doubt whether it is satisfactory technically. He translates *altura* by altitude when the alternative latitude is evidently right. There are passages rather incomprehensible in the translation which the writer, with no knowledge of Spanish but the use of Velasquez' dictionary, suspects might have been better translated. On p. 163 Prado is made to say: "We decided not to weigh anchor until low water and to go with the foresail only to direct the ship, because the waves would carry the ships through the trough of the water, and to anchor at the flow of the tide." The dictionary would apparently allow us to translate this "because the tidal current would carry the ships through the deepest part of the channel." In these passages between the reefs the flood tide runs often at 5 or 6 knots.

The editor of the *Relación* for the Hakluyt Society made no very serious attempt to deduce the ship's track from the narrative, as is evident from the bald delineation of it in the Sketch Map "deduced from dates, latitudes, etc.," which is contained in the pocket at the end of the volume. He was content to be ruled by the supposed necessity of taking the ship down to latitude 11° S., on the authority of Torres, not of Prado, and was glad to do so because he could then call his volume "New Light on the Discovery of Australia." In his review of the volume in the *Journal* for September 1930, 76.252, Mr. E. A. Parkyn considered that the title is unfortunate, since it cannot be said to throw any new light upon the discovery of the continent; the one thing sure is that neither Torres nor Prado for a moment recognized any land as continental. But our reviewer was disposed to accept the route *via* Bligh Channel, suggested by Mr. Logan Jack in 1921, and adopted, contrary to his earlier opinion, by Commander Bayldon in 1930.

The present writer became interested in the problem during an idle moment about 1934, and sent some notes and queries to Miss L. E. Cheesman, who has voyaged in those waters. In 1935 Captain James Duncan, a Fellow of the Society and pearling captain, was in England, and spent a morning in our Map Room with Miss Cheesman over the *Relación*. It will be seen that they made many valuable suggestions. The enquiry was then put aside for more urgent matters, and is only now brought to some sort of conclusion.

The main difficulties in following the course of the *Almiranta* are in the neighbourhood of the actual Torres Strait between Cape York and the coast of New Guinea some 90 miles to the north. But the only parts that are really certain are those at the extreme south-east end of New Guinea about China Strait and Orangerie Bay. Prado describes how they sailed south-west from Espiritu Santo until they were in latitude 21° S., having been instructed to go

as far as 20° or in another version 30°. Here, perhaps 300 miles according to Bayldon from the Queensland coast, they turned away north-west for Manila and on July 14 were confronted by a coast running east and west and were unable to beat eastward against the south-easterly trades to round it. They were therefore compelled to coast along to the west, and after five or six days arrived at the district shown on Prado's Map II, which is unquestionably the neighbourhood of Basilisk Island and the China Strait of Moresby. From the narrative one would judge that they were running along a coast the whole way, but it is evident that what they first sighted was Tagula and that they soon cleared this island and were running along an open reef for the

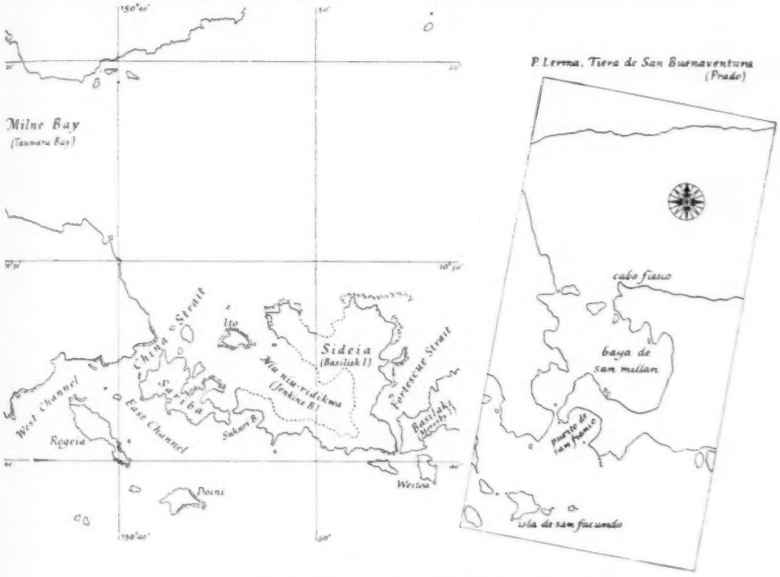
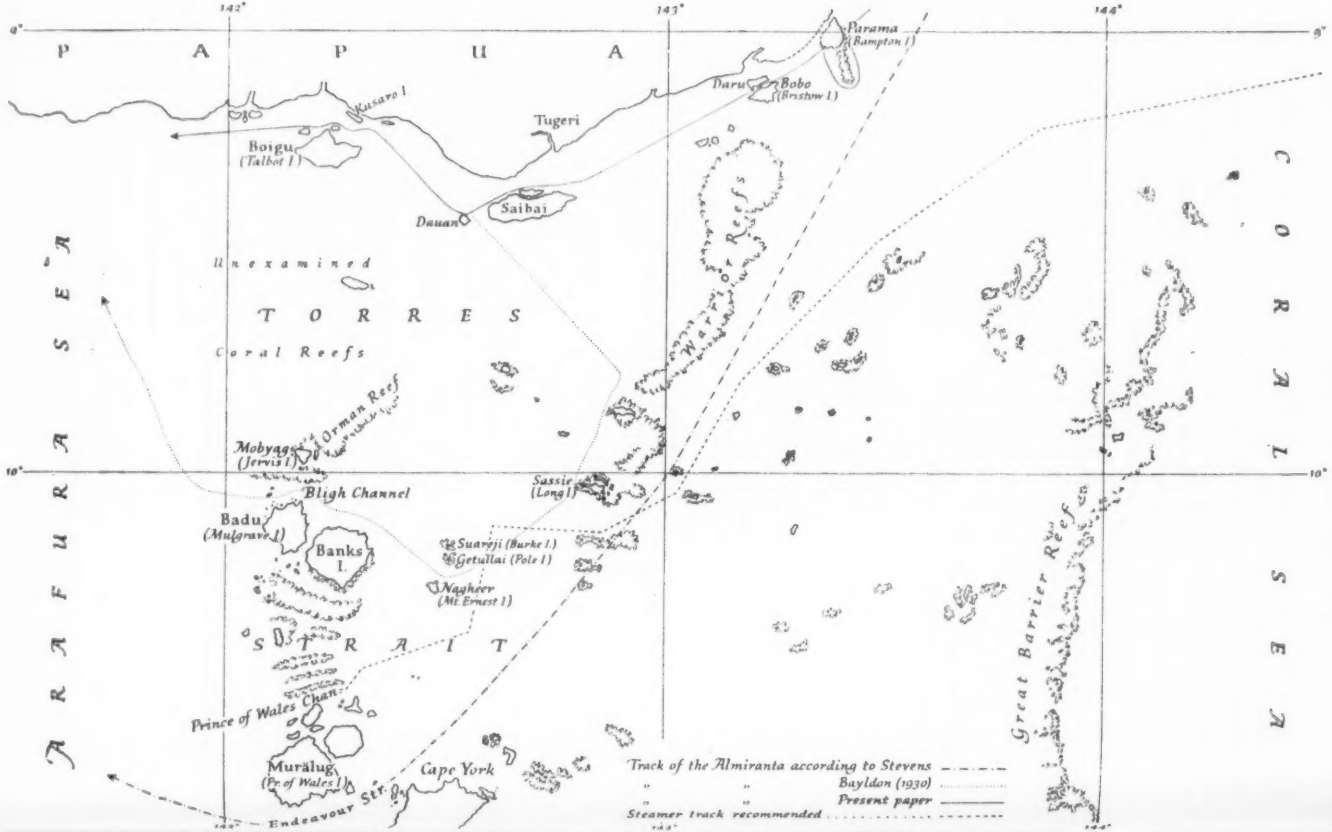


Fig. 1. Prado's Map II and Admiralty chart

greater part of the way until they saw ahead of them a number of pointed islands between which they suspected and found a passage. The comparison in Fig. 1 between Prado's Map II and a recent Admiralty chart shows that Prado's scale was variable but that the relative positions and shapes of these shores are so nearly right that there can be no question of the identification.

They first referred to the place as Port Lerma, but afterwards gave the name San Francisco to the bay in which they first anchored, which seems to be Sukuri Bay, and they took at any rate the launch through the rocky passage thus shown on the chart, and explored as far as Milne Bay but missed the actual China Strait of Moresby. Here they spent something like twenty days and then sailed "twenty leagues or more" westward till they came to the area of Prado's Map III, which is unquestionably Orangerie Bay, though the island is by no means razor-shaped as Prado describes it. Here again they spent


142°
143°
144°
9°
10°
PAPUA
Parama (Rampton I.)
Daru
Bobo (Bristow I.)
Kusaro I.
Tugeri
Boigu (Talbot I.)
Saibai
Dauan
Unexamined
TORRES
Coral Reefs
ARAFURA SEA
Mabuyag (Jervis I.)
Orman Reef
Bligh Channel
Sassie (Long I.)
Badu (Mulgrave I.)
Banks I.
Suarji (Burke I.)
Getullai (Pole I.)
Naghéer (Mt. Ernest I.)
STRAIT
Prince of Wales Chan.
Muralug (Pr. of Wales I.)
Cape York
Str.
Endeavour
Mary Reefs
CORAL SEA
Great Barrier Reef
Track of the Almiranta according to Stevens
" " Bayldon (1930)
" " Present paper
Steamer track recommended

some twelve days and moved a few leagues westward to the island of San Bartolome (Mailu or Toulon Island), which is included in Prado's Map III. Leaving San Bartolome on August 28, they made a quick passage to their Isla de San Juan Bautista which, if their latitude of $8\frac{1}{2}°$ is correct, should be Yule Island, where they stayed four days. From this not very certain point we begin to get into difficulties, for until the eclipse of the moon on September 15 there is no date. The day after they sailed from Yule Island they ran with bare poles in a storm and anchored off a lofty head in a fine bay, which may perhaps be Orokolo, the last high ground along this coast for a long way. Then they went over a bank to $7\frac{1}{2}°$, whence they could not go forward owing to the many shoals and great currents, presumably off the Delta of the Aird River. The narrative seems deficient here, because *next day* they were stopped by a great reef, that "did not last long," so it was not the Warrior Reef, but probably the reef of some 4 miles S.S.E. from Bampton Point, the south-east extremity of Parama or Bampton I. On this reef the sea breaks heavily in the south-east monsoon (*Pacific Islands Pilot*, I, 40). The reef which stopped them had soon come to an end, they changed course again, and reached Malandanza, peopled by tawny people, which is almost certainly Parama. From Parama they went to the Isla de los Perros, described as of the same size as their Malandanza, where they found an abandoned village and a quantity of turtle and masks made of the same shell very well finished. They gave the island the name Isla de los Perros (Isle of Dogs, which disturbed them by howling all night), and it is presumably Bristow Island, which is said by Captain Duncan to be famous for its turtles.

From this island they "went on sounding in search of another among the same shoals, which was a lofty island from which they counted forty others all among the same shoals," and here is a critical point in the identification. The lofty island has been taken for Dauan, which is 795 feet high and the only really lofty island in the neighbourhood, but as will be seen later, Dauan is wanted for a later date, and we suggest that the island among the same shoals as Bristow is Daru, which is only 95 feet high but lofty compared with others in the neighbourhood, and now the seat of the Administrator of Western Papua. Here they found a village with a number of skulls and bones of men who had been eaten, and that is one of the reasons why the island has been identified as Dauan which is opposite the coast of the Tugeri cannibals. But Daru is only 60 miles east of Dauan and the people there in those days may very well have been cannibals too. Daru is close to the mainland of New Guinea and they "tried again to go to the great land, but the shoals were so large" that they could not get across. At this point in the narrative comes the eclipse of the moon dated by Prado September 22 but really the 15th, as we have seen.

Here they adopted the device of weighing anchor at low water and going under the foresail only, which we have discussed above. "It secured," says Prado, "the ships and our lives"; and proceeding thus, at the end of three days they reached a flat island where there were plenty of very large pigeons and trees of plums that have big stones and little flesh; and the whole island was full of pumice stone, so they gave it the name of Isla de Vulcan quemado. This island has both by Commander Bayldon (1925) and by Captain Duncan

been taken for Boigu, but if we are right about Daru, the island is more likely to be Saibai. Pumice stone is frequent on the beaches in Torres Straits; Duncan says now much more frequent on the northern islands than the southern; but Haddon has spoken of islands near Cape York as having the usual pumice pebbles. The recent pumice is generally attributed to the eruption of Krakatoa, and it would be unsafe to argue from its present distribution back to the time of Torres, so that it does not much help. The real reason for identifying this island with Saibai is that from it they went towards others and reached one, the largest, "which greatly resembled the hill of Our Lady of Monserrate" (in Barcelona); so they gave it that name. Now close south-west of Saibai is the island of Dauan, 795 feet high, figured on p. 192 of the *Australia Pilot*, vol. III, 1936.

To make sense of Prado's narrative it is essential to identify Monserrate, and Bayldon, having in 1925 maintained that Torres during the whole voyage coasted as near as possible along the south shore of New Guinea, when he had read the *Relación* of Prado abandoned that view; and in his paper to the Australian Historical Society of 1930 took the *Almiranta* south-east by south from Saibai down to the end of the Warrior Reef, and then S.S.W. to Long Island, which he identified as the pumice island, and thence to Mount Ernest Island, which he took for Monserrate. There seem to be two objections to this hypothesis: first Bayldon has himself said that it would be impossible for a ship with the rig of the *Almiranta* to make good any such course against the south-east trades; and further, the identification of Mount Ernest Island with Monserrate does not fit the narrative which immediately follows.

"We set sail from here in search of other islands and at the end of three days we anchored between two islands to take in water." Now Banks Island, the highest and one of the largest in the Strait, is only 9 miles from Mount Ernest Island. Its large neighbour, Mulgrave Island, lies behind it, and between the two is a strait a mile or two wide, "apparently too shallow even for the smallest craft" (*Australia Pilot*, III, 227). It would not take three days to find Banks Island in full sight only 9 miles away from Mount Ernest Island, and no one would anchor between it and Mulgrave to take in water. We cannot then agree with Commander Bayldon at this point. He would have the ship anchored not between the islands, as Prado says, but on their northern or lee side near the eastern entrance to Bligh Channel. Here the flood tide runs at 6 knots. Prado says that on the following day and for seven more "the contrary currents were so great and strong that it was necessary to have two men at the helm to keep the ship's head against the stream" and Bayldon explains that this "caused their vessels to sheer about so wildly that they had to steer them, whilst lying at anchor, in the same manner as if they had been sailing at the same rate, in order to prevent parting their cables." But the current at flood was westward, the way they wanted to go, and what kept them at anchor with such labour, for eight days after taking in water, is not explained.

We suggest therefore that Prado's Monserrate is not Mount Ernest Island but Dauan, and take up the narrative from this point. After three days they anchored between two islands, where the men were much bitten by flies, and the Indians fled to the hills. There are no hills anywhere west of Dauan.

Kusaro (Kussa) Island lies close offshore from the low mangrove coast with wooded country behind: it may be the Isla de las Cantarides (dictionary says the Spanish or blistering fly, *Lytta vesicatoria L.*) and the adjacent mangroves taken for another island; but a "good supply of very clear water" seems unlikely there. Haddon in Reports of the Cambridge Expedition to Torres Straits, vol. V, 19, says that Boigu has a famous water-hole of good water: but this island does not fit in well here. Then came the eight days of contrary currents; two islands with a very narrow channel between them, possibly Boigu and the islet to the north; then other islands to the north, one bigger, where the ship anchored in 5 fathoms at half a league from the island, and at midnight the ship bumped, fortunately on a clay bottom. One cannot say that for these fifteen days after leaving Monserrate the likeness between text and chart is close: but the text is vague, the chart is of characterless coast, and there is no important contradiction. We can say no more than they seem to have been held up among the Talbot Islands and made on an average only 3 or 4 miles a day.

Thenceforth they found more water and had not to wait for the tides. With a strong breeze they "went out towards the north and discovered a lofty cape of the great country, we steered towards it and saw on anchoring that the coast ran in a different direction and perceived that there was an end of coasting." "We were among these rocks and shoals for 34 days," says Prado, which they could hardly have done if the *Almiranta* had made the diversion to Mount Ernest and Banks Islands. The Cabo de San Pablo is without question False Cape, though this south-western extremity of Frederik Hendrik Island cannot be called high: the Pilot says "from westward at low water it is possible to run aground before sighting the land." And they had come out to the west, not north. These two discrepancies give a fair indication of Prado's quality as narrator. Piecing the narrative before and after one may be quite certain that his Cabo de San Pablo is False Cape; yet neither the course thither nor the cape itself is accurately described.

Nor are his latitudes always helpful; but they begin well. In the narrative he has

The beginning of the land in ..	12°	S. point of Tagula is ..	11° 38′ S.
Port Lerma	10½	Sukuri Bay	10 38
I. San Bartolome (Ratiles) ..	8½	Mailu (Toulon I.) ..	10 24
I. San Juan Bautista	8½	Yule Island	8 50
I. Malandanza	9	Parama (Bampton I.) ..	9 00
I. de los Perros	10	Bobo (Bristow I.) ..	9 03
Cabo de San Pablo	8½	False Cape	8 26
In the legends on the three maps by Prado			
Buenaventura disc'd in.. ..	10⅔	Sukuri Bay as above ..	10 38
Puerto de Monte Rey	10⅙	Mullens Harbour ..	10 30
Bay of San Lorenzo	3⅔	Head of Triton Bay ..	3 45
Torres' Letter has			
Beginning of New Guinea ..	11½	S. point of Tagula (above)	11 38
Head of Gulf of Papua ..	7½	about	7 50
Went S.W. to	11		
Coast turning N.E.	5	False Cape	8 26

Prado's $8^1_2°$ for San Bartolomeo is in numerals, more liable to errors of copying than his 10° for I. de los Perros, which is written *diez*. These two are discordant: the rest as good as may be. But they are so infrequent. Prado gives no latitude at all for the five weeks about September 5 to October 9 which are the important weeks. Torres also started well: but his much-discussed "once grados" (11°), south of Cape York, is inconsistent with his words "we went along on this bank for two months" which strongly suggest a coasting voyage as far as False Cape, for which he clearly says "en sinco grados de altura" when it should be 8^1_2. The conclusion is that the latitudes given by Torres and by Prado are sometimes irreconcilable with the narrative, and that the latter may be preferred. The narratives of both read as if they were trying always to keep as close as possible to the coast of New Guinea, and Markham in his third map shows roughly the route of Torres thus. Bayldon in his paper of 1925 strongly supported this interpretation. Stevens on the strength of a single latitude from Torres took them right down to the south through Endeavour Strait, in defiance of the narrative which he had discovered and published, and Bayldon, against all his arguments of 1925, took them through the Bligh passage, with Mount Ernest Island for Prado's Monserrate. The principal point of our argument is that Daru, not Dauan, is the island of the cannibals, and that Dauan is Monserrate. If that is acceptable, the voyage detailed in the *Relación* is a coasting voyage all the way to False Cape, and has no part whatever in the discovery of Australia.

A. R. H.

A SURVEY OF WAVES

STEREOPHOTOGRAMMETRISCHE WELLENAUFNAHMEN. By A. SCHUMACHER. *Berlin: De Gruyter*, 1939. 11½×9 *inches; 86 pages; maps and photographs. RM*13. (*Atlas containing 30 coloured charts and 21 sheets of diagrams*)

ALTHOUGH we have been long familiar with the broad characteristics of deep-sea waves, it is only recently that serious attention has been given to the problem of their precise measurement. In this country Dr. Vaughan Cornish has been almost the sole worker in the field, but, as he himself confesses, it is very difficult, if not impossible, to obtain trustworthy results from infrequent and isolated observations made by eye or at best with the help of a stop-watch. Even if we grant that seafarers become, by dint of long experience, good judges of the height and length of individual waves, it is clearly not possible for the eye to acquire an exact image of the wave-pattern over any distance. Consequently it was not until the camera was adapted for the purpose that wave measurement reached any degree of precision.

Most of the credit for this technical advance is due to the Germans who at intervals since 1904 have equipped various vessels with experimental apparatus and have now published the wave findings of the 1925–27 expedition of S.S. *Meteor* in the North and South Atlantic—the most systematic and comprehensive oceanographic survey ever undertaken. With these results are included those obtained during the early months of 1929 by S.S. *Deutschland*, taken while she was plying between Hamburg and New York. Briefly the wave-measuring gear consisted of two main and two subsidiary cameras, mounted on a rigid bar usually carried on the foremast athwartship, and stayed to the deck. The main cameras were mounted to take stereographic pairs on a 6-metre base, 13–14 metres above the water-line on the *Meteor* and 24 metres on the *Deutschland*. The subsidiary cameras faced each other at opposite ends of the bar, their optical axes being coincident, *i.e.* parallel to the bar. While the main cameras were "shooting" the waves, the subsidiary ones were photographing the main cameras together with the horizon beyond, so that when the work of reduction came to be done in the laboratory the existence of "play" could be detected and compensated. The four exposures were carefully synchronized. Generally the bows of the ship were head on to the main wave system when the foremast position was being used and when the vessel was keeping station. Occasionally when very heavy seas were running, or when the ship was steaming into the wind, a less exposed position amidships was used to minimize the fogging of the plates.

The plates were plotted on the stereoplanigraph giving for each sea station a map of the water-surface up to 600 metres from the ship, contoured at 20 cms. vertical interval. From these, together with the cross-sections constructed from them, we are able to build up a remarkably complete picture not only of the individual waves, but also of the inter-lacing of wave systems of different lengths and directions. Tables summarizing the results of all this work give, among other things, the mean wave-length, wave-height (crest-line and peaks), the gradient of windward and leeward slopes of individual waves, the area of the wave-profile (from this the weight of water in a wave can be calculated), the crest angle, the length of the component slopes (owing to wind action and the trochoidal shape of a wave these are seldom the same) and the factor by which the wave-height must be multiplied to obtain the vertical distance between the still-water level and the wave-top.

In view of the prodigious amount of work put into the reduction of the data it is disappointing to find that the author of the monograph accompanying the

Atlas makes little attempt to interpret his results, some of which are very surprising. The following are a random selection culled from tables in the text:

i. The height/length ratio rarely rises above 1 : 20; when it does the waves are either of short length, less than 75 metres, or running contrary to the wind.

ii. Wave peaks (*kuppen*) seldom exceed the average wave-height by more than 10 per cent., unless occurring at the intersection of two or more wave systems (analysis of the contoured charts makes it quite clear that all peaks of 3 metres and over were, without exception, formed in this way). The highest peak observed in the whole expedition was one of 9·4 metres; with a wave-length of only 138 metres this value lies well above Schumacher's mean maximum value and was due to a wind of Force 9, recently risen, working on a heavy swell running from a contrary direction. The longest wave recorded was one of roughly 330 metres with a peak of 8·8 metres.[1]

iii. Although not committing himself to a maximum height/length ratio for the larger wave-lengths Schumacher lays down these values for short and medium waves, and equates them with the Douglas sea scale as follows:

Wave-height ..	0·5	1·0	1·5	2·8	4·3	6·7>	7·0 metres	
Wave-length ..	10	17·5	25	45	80	125	>125	metres
Douglas Sea Scale	1		2	3	4	5	6	

iv. When wind and wave are concordant in direction and the wind-speed is greater than the wave-speed, the front slope of an advancing wave is consistently, if only slightly, steeper than the rear slope. Generalizing, the front/rear slope ratio increases with the wind/wave ratio; when wind=wave-speed the average ratio is 5 : 4 approximately; when wind-speed is more than twice the wave-speed the ratio is 3 : 2. At the same time when the wind falls below wave-speed the ratio front/rear slope remains above unity until the wind/wave-speed ratio drops to 2 : 5 when the two slopes become equal, a result which seems to imply that wind having a relative motion opposite to that of the wave exerts very little "breaking" power, and contributes little to the decay of the wave-system.

v. On more than one occasion Schumacher records a wave-crest angle less than 120 degrees—the limiting value given by Stokes; the lowest figure is 103 degrees occurring with a wind of Force 7, and with a wave-length of 150 metres and 7·0 metre peak. However, nearly 80 per cent. of the measured crest angles ranged between 149 and 165 degrees.

As for the text itself, this is unnecessarily wordy, devoting nearly sixty folio pages to a repetitive account of the essential features of each chart, augmented, in the case of the *Deutschland* reports, by a summary of the synoptic situation. At times it is hard to believe that the author could have studied the charts for so long and learned so little, for he tells us next to nothing about such matters as the growth of waves, the effect of cross-winds on existing sea and swell, the coexistence of swell of different periods and directions (up to eight distinct trend-lines can be traced on some of the charts), the importance of fetch and of the duration of steady wind for wave-height, or the variation of the height/length ratio with the wind/wave-speed ratio. His own attributions of direction are not always to be trusted, and it is obvious that some of his analysed wave-lengths are hybrids, the result of the interlacing of different wave-systems, *i.e.* they are not true wave-lengths. But in the tables, cross-sections, and charts (thirty in all, and on the generous scale of 1 : 1000) the interested student possesses an unparalleled wealth of wave data which would repay months of careful study and go far to answer some, though not all, of these age-old problems.

GEORGE H. T. KIMBLE

[1] According to Weinblum and Block the record wave-height, measured in this way, is 16·0 metres, and the maximum difference between crest and trough 18·5 metres.

REVIEWS

EUROPE

ENGLAND AND THE FARMER: a symposium. Edited by H. J. MASSINGHAM. *London: B. T. Batsford*, 1941. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 154 pages; illustrations.* 10*s* 6*d*

This book is a series of essays by various writers on agriculture; it deals rather with policies than with facts; there are no discussions of the relations of agricultural systems to their environment, such as would interest the geographer, and the only chapter discussing specific problems of soil management is one by Sir George Stapledon on the improvement of grasslands. The more general reader not in search of geographical material will find much of interest in the views here expressed. Broadly speaking they are to the effect that our present agricultural system is wrongly based; that it should be founded on small self-contained family farms which implies a peasant life for those who work them. No one writes from the workers' point of view to show how far this kind of life would be acceptable, and it may well be doubted whether many who had the option of an alternative would agree to the long hours and hard work involved. In spite of much official encouragement and praise of the life by writers, the number of small holdings continues to fall in England and Wales, and the reason for leaving is usually that the return for the labour is too small. It is impossible to forecast what may happen after the war, and if Marshal Pétain succeeds in his declared purpose of turning France back into a peasant country dependent on the goodwill of a powerful neighbour we may yet see whether the expected moral and physical regeneration comes about. From this experiment, if it is ever really carried out, we shall learn a great deal. A chapter by Adrian Bell on the Family Farm sets out the advantages of this mode of life for those who like it. As one expects from a Batsford book, the illustrations are excellent, though their relation to the text is not always clear. E. J. R.

ASIA

POGRANICHNAYA JUNGARIYA, III (Frontier Jungariya). Geographical and geological description; Part 2, geological sketch. By V. A. OBRUCHEV. *Moscow and Leningrad: Acad. of Science of U.S.S.R.*, 1940. 10×6 *inches; 292 pages; text figures, illustrations, and geological map* 1/500,000

Academician Obruchev led expeditions to Jungariya in 1905, 1906, and 1909. His diaries appeared in vol. I of this work, vol. II gave M. A. Usov's petrographic description of the geological specimens; vol. III, Part 1, with chapters I–IV, the geographical description, orography, and hydrography, and a bibliography of 173 headings appeared in 1932.

The area dealt with extends from long. 82°–86° 30′ E., lat. 45°–47° 30′ N. It includes the frontier between Russia and China for 400 kilometres north from lake Ebi-Nor and the Jungariya Gates to the Tarbagatay Ridge and then east along this past Zaysan to Mus-Tau. Three-quarters of the area is over the Chinese border, as shown upon the map.

After a bibliography of fifty-one titles supplementing that in Part 1, the text contains Chapter V, geological structure of heights and depressions; VI, stratigraphic outline (no preCambrian or Cambrian) beginning with Silurian; VII, tectonics, geological history, and geomorphology; and VIII, a very important chapter on useful minerals, being an improved reissue of a study by the author

in *Tsvetmetalizdat* (Non-ferrous metal publications) No. 68, 1932. Only gold has hitherto attracted much attention, the author thinks it well worth working. The other metals are mostly present but do not amount to much. There is plenty of coal especially on the river Kenderlyk, also oil and asphalt in considerable quantities.

Though the author's expeditions were in 1905–09, his information is up to date as he has incorporated everything published since, particularly the work of V. P. Nekhoroshev, except any results there may be from Sven Hedin's last expedition. It is pleasant to see the references to the work on Jurassic plants by A. C. Seward who named a new Ginko after our author.

We still await Part 3, description of climate, flora, fauna, population, and communications of the area. Let us hope that the author will succeed therewith in bringing his great work to a successful conclusion. Perhaps in it our Honorary Member will vouchsafe a summary in English. E. H. M.

AFRICA

THE DIARY OF DR. ANDREW SMITH. Vol. II. Edited by PERCIVAL R. KIRBY. *Cape Town: The Van Riebeeck Society, No.* 21, 1940. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 342 pages; illustrations. To members* 12*s*

The first volume of this work published in 1939 was reviewed in the *Journal* for August 1940. The second volume finds Andrew Smith and his companions, including Dr. Moffat, at Motito, a French Protestant Mission Station a few miles north of Kuruman. The party proceeded northwards and crossing what is now the Bechuanaland-Transvaal frontier near the position of Mafeking entered the Matabele country where Mzilikazi (Masalacatzie) held sway. Smith met the dreaded Matabele chieftain at a kraal on the Tolane river where he had retired on account of smallpox which was prevalent at that time. He had very satisfactory relations with Mzilikazi and arranged to make a circular tour eastwards round the Magaliesberg mountains to explore the country, practically unknown at that time. Smith was accompanied by Matabele guides who however had been instructed by their Chief to prevent him going too far or seeing too much. After his return to Tolane he made a second excursion to the north following the Marico and the Limpopo rivers until on 4 September 1835 he reached the latitude of the Tropic of Capricorn which he had fixed as the northernmost limit of his journey. On the return journey southwards he passed through Kuruman and crossing the Orange river at Hopetown reached Graaff-Reinet in Cape Colony on 4 January 1836.

In addition to the description of the scenery the diary contains much about the native tribes met with and particularly of the relations of the Matabele with the Bechuana and other peoples which the conquering hordes of the former held in strict subjection. There is also a great deal of matter dealing with animals and birds. In modern zoology it is of great importance to know the exact localities in which new species were first discovered, and in this respect Dr. Smith in his subsequently published 'Zoology of South Africa' was somewhat vague. The diary affords a most useful clue to this matter, and it is to be regretted more attention was not paid it by the Editor. It would not have been difficult in a footnote to have identified Dr. Smith's often rather illusive names in the diary with those in the 'Zoology' and with modern nomenclature, and this would have increased the value of the publication to zoologists. To some extent this has been done in an index compiled by Mr. Austin Roberts of the Pretoria Museum, but it is incomplete.

There is a good portrait of Sir Andrew Smith reproduced from an anonymous

picture now in the R.A.M. College at Millbank as well as a series of photographs from the sketches made by Charles Bell, the artist who accompanied the expedition. The map promised in the first volume shows clearly the route and the camping places of the journey in relation to the present-day geography, and is a most welcome addition to the second. W. L. S.

I WENT TO TRISTAN. By ALLAN B. CRAWFORD. *London: Hodder and Stoughton*, 1941. 9×6 *inches; 268 pages; illustrations, sketches, and maps.* 18*s*

Mr. Crawford's is the third book about Tristan in little over a year; the others, an outstanding history of the island up to 1902 by J. Brander and an account of the visit of a Norwegian scientific expedition during the summer of 1938 by its leader Dr. Cristophersen, were reviewed in the *Journal* for November 1940. Mr. Crawford was on his way to South Africa in the same ship as Dr. Cristophersen, and hearing about the island he was so keen to join the expedition that it was soon arranged that he should go as surveyor; he had no previous experience, but he borrowed text-books and received some practical training in Cape Town.

On Tristan Mr. Crawford had unusual opportunities; his surveying expeditions made him familiar with all parts of the island and brought him into close contact with the islanders who took turns to help with the survey—setting up the stations and making camps. Much of the survey was done from gradual slopes at a height of 1000–2000 feet between the steep coastal cliffs and the final cone of the peak; they forced their way through low bushes and tree-ferns, climbing the sides of the deep gulleys which radiate from the peak like the spokes of a wheel; they were often in the cloud which usually hangs about the lower part of the peak, and there were many days of wind and rain; a small tent was however generally adequate and there was plenty of fuel. Later they made a coastal traverse along the narrow beaches between the small areas of low-lying land that are found at a few points between the steep cliffs and the sea. Several ascents were made of the main peak which was found to be 6760 feet high.

A list of the population in March 1938 is given in an appendix; the total was one hundred and eighty-six, and the numbers of males and females were practically the same The history of the island shows that it cannot satisfactorily support such a large population, and without the regular visit of a government vessel, and the charity of the Tristan da Cunha Fund and the Society for the Propagation of the Gospel, there would be much suffering. While the Norwegians were there the Missionary was able to make a small issue to every family every two to four weeks; their ration of such things as tea and sugar is very small compared with our war-time allowance. The island has now a number of Roman Catholics, who seem to get an extra share from parcels addressed to "The Roman Catholics of Tristan da Cunha." Nine of the men on the island have been away for long periods but have returned to settle there; Charlie Green is "the only man on the island who can drive a tram." Mr. Crawford gives a good account of the islanders' mentality and physique; he received very intelligent help from some of them, and even after his four months of active life he felt no match for them in endurance.

The survey showed the coastline to differ considerably in detail from the existing chart which was largely due to Captain Denham of H.M.S. *Herald*, who was there for two days in 1852. The positions of the neighbouring Inaccessible and Nightingale islands had been reported incorrect by H.M.S. *Challenger* in 1873, but the report was overlooked—the Hydrographic Department tells the story against itself—till similar corrections were advised by R.R.S. *Discovery II* in 1933; the new positions still depended to some extent on the chart of the

coastline, and the new map makes another small adjustment to the position of Nightingale Island.

Mr. Crawford left Tristan in H.M.S. *Milford*, and gives a short description of her visit to Gough Island during which this island was also proclaimed a Dependency of St. Helena. He received valuable help in making his finished chart from the staff of the Commander-in-Chief of the Africa Station in Simon's Town. G. E. R. D.

POLAR REGIONS

GEOMORPHOLOGISCHE FORSCHUNGEN IM NÖRDLICHEN Andréeland. (Nord-Spitzbergen.) By WILHELM DEGE. *Lengerich i. W.* 1938. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 112 pages; illustrations and diagrams*

This is an account of the geomorphology of Northern Andréeland, West Spitsbergen, written by Wilhelm Dege as a dissertation for the doctoral degree of the University of Munster. The area dealt with covers that part of the peninsula between Woodfjord and Widjefjord lying north of 79° 35′ N. It is this district that he calls Northern Andréeland. It is of interest to note that the whole of this peninsula carries the name Andréeland on the German chart of Spitsbergen, but the British Admiralty chart follows Gerard de Geer and confines the name to the area westward of Dicksonfjord (off Isfjord). The name does not appear on the Norwegian charts and the decision of the Norges Svalbard og Ishavs-Undersøkelser on the place-names of Svalbard, which is being prepared by Dosent Adolf Hoel, is not yet available.

The thesis embodies the results of research work in Spitsbergen in 1935 and 1936, while use is also made of field work carried out on various visits to Norway. The first part is introductory; the contributions of previous workers are briefly outlined and those problems which appear to merit more detailed attention are noted. There follows a short description of the topography, and the influence of geology and climate as general factors in the evolution of the land forms is dealt with at some length. The geomorphology of this area, in common with the greater part of Spitsbergen, falls naturally into three aspects, the foreland or coastal zone, the plateau area, and the intermediate zone lying between. The second part of the book is based upon this broad division. The foreland, largely a coastal fringe of detrital accumulation, is considered first. The influence of wind and wave action, frost, solifluction, melt-water, and ice and snow patches, is enumerated in some detail. The smaller wide U-shaped valleys, which have stone and boulder beds, and were formed by the melt-water flood conditions, receive special attention. The dominant aspects of the intermediate zone are the raised features and accumulation cones. Dr. Dege divides the raised features into an older and younger post-glacial series of terraces, the heights of which are noted on both the east and west coasts of the peninsula. There follows an examination of the relation of these raised features to others observed at various times and places throughout Spitsbergen (altogether seventy-two terraces from nineteen localities). It is questionable however whether it is yet possible to correlate on such a large scale, for few heights have been determined by accurate instrumental methods. Moreover in a region where tilting and independent recovery by fault blocks is a distinct possibility, the height alone of a terrace can be of little value for correlation. The section on the fans and cones, which produce the "eggtimer" mountains so typical of the intermediate zone, is of considerable interest, as this aspect of arctic topography has hitherto received little attention. The plateau area of the interior forms the concluding section followed by a summary of the whole.

With such a comprehensive range within the confines of a doctoral thesis there are few opportunities for an extensive development of the many problems touched upon. Yet the treatment rarely becomes superficial; Dr. Dege has succeeded in bringing together much useful information, there are many comparisons with Norway and Greenland, and the views of others are freely quoted throughout. There would however appear one great deficiency. It is unfortunate that accurate surveys of the features discussed were not made. Many of the problems of the raised features would doubtless have found a ready solution if accurate mapping and levelling had been undertaken. The two sketch-maps in the book are of little use. Thirty-six photographs illustrate many aspects and a detailed list of some 170 references is given. W. G. V. B.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

THE PHYSICS OF BLOWN SAND AND DESERT DUNES. By Lieut.-Colonel R. A. Bagnold, r.e. *London: Methuen and Co.*, 1941. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xx+265 *pages; illustrations and diagrams.* 24*s*

Excellent descriptions of the phenomena of sand forms have been given in the works of Dr. Vaughan Cornish, who also goes some way towards explanations. My impression, after making some attempts, was that while a fuller theory was desirable, its construction would be very difficult. In the present book Colonel Bagnold has done it, and the result is admirable. A large part deals with direct experiments in a wind-tunnel carried out by the author himself, and with the interpretation of the results by modern hydrodynamics. It is found that the grains are transported in three ways. The finest, called dust, can be carried indefinitely in a turbulent wind so long as this remains constant. (I am not quite satisfied with the theory given for this. For any size of grain there is a limiting rate of fall in still air. Bagnold argues that if this is less than the average upward component of the eddy-velocities in turbulent motion the grains cannot settle. But the eddy velocities are as much downwards as upwards, otherwise a vacuum would be created. Presumably dust settles steadily relative to the eddy that it is in, but when it leaves one rising current it on the whole enters another rising one more often than a descending one: this seems to be necessary since the type of transport considered does happen, but a full explanation must consider the separate eddies, and hydrodynamics is not yet ready to do so.) Grains of intermediate size can be lifted from the ground and are accelerated by the wind until they hit the ground again. This type of movement is called saltation. They may rebound, propel other particles into the air, or drive them along the ground in surface creep. There is what Bagnold calls an impact threshold, representing the velocity of wind needed to produce the last type. Both are amenable to calculation. The continual loss of energy due to imperfect restitution on impact and to solid friction implies a higher resistance to the wind than a rigid surface gives. Hence a wind passing from hard ground to mobile sand has its velocity reduced. Bagnold argues that the reduction of velocity will be the same at all heights, but if this was true we should be contradicting the equation of continuity—air would accumulate at the boundary. It is however probably true within the range of height that concerns him.

It is found that grains in saltation descend at an angle of about 12 degrees, varying little with their velocity. In ripple formation the windward side of a slope is exposed to the falling grains, which drive the surface ones up the slope. The leeward side however is sheltered and there is nothing to take them down it. Hence a small irregularity of the surface tends to grow. The explanation of the characteristic wave-length is very beautiful. For a given size of grain and a

given wind velocity there is a characteristic mean length of path in saltation, which is found to agree very closely with the wave-length of the ripples produced. With this adjustment every grain produces its maximum effect in each jump; if the ripples were longer some grains would strike the same rising slope twice without reaching their maximum velocity, and if they were shorter some would miss some slopes altogether.

Detailed accounts are given of the methods of formation of the various types of dune. Abundant references are given, but I miss one to the work of the late F. M. Exner (*Ergebnisse d. Kosmischen Physik* 1, 1931, 373–445). So far as they overlap Bagnold goes much further, but as the subject grows Exner's discussions of related problems (river meanders, sandbanks, and so on) should be a quarry for suggestions. Bagnold emphasizes a considerable difference between transport by air and by water. Under the latter the velocity needed to lift a given grain is much smaller on account of the larger density; but it follows that the velocities acquired by the grains are also smaller and will not be enough to propel other grains when they strike the bottom again. H. J.

GENERAL

COLLOQUIAL PERSIAN. By L. P. ELWELL-SUTTON. *London: Kegan, Paul, Trench, Trubner and Co.*, 1941. $7\frac{1}{2} \times 5$ *inches;* viii+140 *pages.* 3*s* 6*d*

Mr. Elwell-Sutton describes his book as *Colloquial Persian*, and it should be reviewed from this angle.

Any writer of a Persian text-book is faced with the difficult and vexed question of transcription, and as the author points out in his chapter on pronunciation, "the printed word can only give an idea of the sounds . . . of the Persian." It is however difficult to understand why he has departed from the standard transcription followed by St. Clair Tisdall and other authorities, as the system which he has adopted does not appear to be phonetically more accurate. The standard spelling of *i* (for the ezafè), *suwar* and *maidan* approximate more closely to the Persian pronunciation than his *e*, *sevâr* and *mêdân*. The strangest feature of his transcription however is his use of *gh* to represent the letters غ (*gh*) and ق (*q*) which differ considerably in pronunciation and denote totally different roots and word formations. To use the same transcription must therefore confuse the student who learns the Persian characters at a later date.

Mr. Elwell-Sutton's book gives an extremely thorough and comprehensive introduction to the Persian language: too thorough perhaps for colloquial uses.

Persian grammar is basically simple, but its treatment in this book makes it seem somewhat complicated. Lesson 6 dealing with compound verbs is surely unnecessary. It would be easier to learn the simple verbs with their tenses and conjugations and then be led on to combine them with nouns, verbal nouns, and adjectives, when the meaning and usage would become self evident. An undue amount of space is devoted in Lesson 1 to the Ezafè. It is made to appear more difficult than it really is and would be more suitably introduced at a later stage in the book.

The early lessons appear to contain too many points for the student to digest, and tend to introduce colloquial idioms before the basic forms can be properly mastered, while contractions in the forms of verbs are introduced before the full form of the verb is sufficiently described. In many cases exercises contain somewhat complicated examples or introduce idioms which have not formed the subject of the lesson to which they refer, *e.g.* Exercises 2, 3, 7, and 8.

It will be understood that the foregoing comments, with the exception of the

remarks on transcription, refer only to the presentment of the subject, which must of course be largely a question of opinion. The attitude of mind to the elementary study of a language varies so greatly that it is neither possible nor advisable to dogmatize. The matter itself is excellent. The chapter on Conversations is admirable and the system of classification adopted will greatly simplify the students' work. The arrangement and the contents of the vocabulary are extremely good: the book as a whole most comprehensive, full of valuable instruction and information. A fair knowledge of its contents will constitute a very complete equipment for the newcomer to Persian and to Iran.

A. W. F.

UNPATHED WATERS: studies in the influence of voyagers on Elizabethan literature. By ROBERT CAWLEY. *Princeton: University Press*, 1940 (*Oxford University Press*). 9×6 *inches;* x+268 *pages*. $3.75 (22*s* 6*d*)

During some twenty years of academic life Dr. Robert Cawley has gallantly essayed the well-nigh impossible task of mastering two vast fields of knowledge: Elizabethan literature and the Elizabethan voyages. Both subjects are taken in their widest sense, and are examined in order to trace the influence of the voyagers upon the poets and dramatists of the age. The reactions of individual writers to the sudden expansion of the known world have been studied before, often with great minuteness, but no one has hitherto attempted a really comprehensive review of the problem as a whole. It may be questioned whether the relations between life and letters, even of a particular aspect of life and a particular range of literary output, can justly be termed a single problem: if so, it is as many-facetted as a diamond, and cannot be solved and dismissed in a single book. This Dr. Cawley has already discovered. A series of articles was followed in 1938 by 'The voyagers and Elizabethan drama,' and this in turn by 'Unpathed waters,' the work under review, which has for subtitle: Studies in the influence of the voyagers on Elizabethan literature. Since many of the Elizabethans were but fledglings in the "nest of singing birds" when Gloriana died the period covered embraces the reigns of James I and Charles I, and the generation to which Sir William Davenant, the Poet Laureate, belonged. It was equally impossible to limit the meaning of voyagers to those making actual journeys of discovery by sea, and for "voyagers" one could almost substitute "geography and travel." Dr. Cawley harks back to the heritage of the Middle Ages, and cites examples of the ways in which Elizabethan writers used and transmuted such concepts as those of the Fortunate Isles, of Floating Islands, the Terrestrial Paradise, Ophir, Thule, the lost Atlantis, and other lands of myth and legend. One by one, as knowledge dethroned speculation now in this part of the world and now in that, these fabled lands with all their endowment of mystery, magic, and beauty, their strange beasts and stranger men were removed from the category of fact to that of fancy. The poets and dramatists then entered into full possession. "I once did see" (wrote George Chapman) "In my young travels through Armenia An angry unicorn in his full career. . . ." And Dekker invites his hearers "into those *Insulae fortunatae* which are imbraced about with waters sweete, redolent, and Cristoline."

The influence exercised by maps is also discussed, for Shakespeare's famous simile, likening Malvolio's face creased in smiles to the cross-lined map in Hakluyt's Voyages, has sent every literary student hunting in that field. Yet, save for the authenticated use made by Marlowe of Ortelius' Atlas in writing his drama, *Tamburlaine*, the Elizabethan writers paid but superficial attention to maps and globes. Most of Dr. Cawley's quotations show that their fancy has been caught by the accidental features of the map, the spouting whales, the

wind-puffing cherubs, or sailors, or perhaps by the intriguing legend Terra Incognita. Even more frequently, it is the rudiments of mathematical geography found in their school text-books that appeal to the poets. The Zodiac, the Zones, the Zenith, the Tropics, the Equinoctial: these are strange and lovely sounding words, whose precise meaning matters little. The poet Donne however made serious use of Astronomy in his verse, for he was following with insight those discoveries which led English mathematicians to discard the Ptolemaic for the Copernican system.

The glamour of sea-voyaging for the landsman rests in part at least on what seems to him the mysterious means by which the master directs the ship to her destination. Shakespeare's "unpath'd waters" which give their title to these studies are matched by William Brown's "Seeking new paths i' th' pathless ocean" and George Wither's "Pathless ways through many seas unknowne." Save in verse written for an "occasion," like that of Thomas Churchyard or Henry Roberts, or in masques, pageants, and interludes that were deliberately topical, the number of specific references to historical voyages and newly discovered lands is small, and writers show more familiarity with the east than with the west. There was indeed little romance and much horror in the vast wildernesses of America with their savage inhabitants: in the Orient kings and princes ruled over their barbarous courts amid scenes of luxury and cruelty that provided material ready to the dramatist's hand.

The Elizabethan seaman was a rough and tough customer, even for an age in which manners in general were anything but nice. He found his way into many a stage play, and his hardships were accepted as typifying an arduous and unrewarded career. "You must to Sea, . . . and there lye pickled in a Powdering tub, and break your teeth with Biskets and hard Beef." Not only the seamen, but the ships, majestic with their swelling spread of canvas and bravery of banners and pennants, fired the imagination of the poet:

> "How like a younker or a prodigal
> The scarfed bark puts from her native bay
> Hugg'd and embraced by the strumpet wind!"

Shakespeare has many such marine pictures, and as Dr. Cawley points out, they are most often taken from the vantage point of the land:

> "As one on shore
> Gazing upon a late embarked friend,
> Till the wilde waves will have him seene no more,
> Whose ridges with the meeting cloudes contend."

Abundant though the author's quotations are, he has certainly not exhausted his store, and perhaps he may one day prepare from it an anthology of all that is most beautiful and arresting, so that the reader may enjoy the poets and dramatists of Renaissance England without asking why they wrote thus of strange lands and seas. E. G. R. T.

THE MONTHLY RECORD

THE UNITED STATES ANTARCTIC EXPEDITION IN GRAHAM LAND

The *Geographical Review* for July 1941 contains an important preliminary account of the United States Antarctic Expedition 1939–41 which has recently returned. Of the party working from the West Base at the Bay of Whales we had heard a little, but of the East Base party under the leadership of Richard B. Black in Graham Land we in England had heard nothing since they were left on Neny Island on 21 March 1940 (*Geographical Journal* 96 (1940) 224). This account has been put together by Lieut.-Commander R. A. J. English, U.S.N., the Executive Secretary of the U.S. Antarctic Service, from radio despatches received at headquarters in Washington during the absence of the expedition. An editorial note says that all data concerning geographical features and especially their exact positions are necessarily preliminary. Final clarification must await the preparation of the results by members of the expedition.

Neny Island is in Marguerite Bay, a few miles south of Barry Island, the southern base of the British Graham Land Expedition of 1934–37. From this East Base a first flight in the Condor plane was made southward on May 20 as far as Cape Jeremy, to prospect sledging routes. The next day a cache was made by the aeroplane on the Wordie shelf-ice. In the dark of July and August sledging parties had reconnoitred the route eastward across the plateau and on September 10 a depot-laying party had laid a cache at the head of one of the glaciers descending to the Weddell Sea.

On September 21 the Condor made a flight eastward across the peninsula, then down the western coast of the Weddell Sea from 68° to 69° S., and returned to the base. On September 28 six men flew south to the shelf-ice cache, east to the Weddell coast, north along the coast, and back to the base. In the early part of October the cache on the eastern part of the peninsula was further stocked by sledge. But between September 28 and November 4 bad weather prevented flying and the season must have been still too early for long sledging.

The main work of the brief season began on November 4, when the Condor was flown south-west to skirt the northern end of Alexander I Land, and then south-easterly to the western trend of King George the Sixth Sound.

On November 7 two sledging parties proceeded to the Wordie cache and worked up southwards on to the plateau. Meanwhile the Condor plane had laid a depot on the floor of the Sound, south-west of the Batterbee Mountains. On November 22 the two parties on the plateau separated. The survey party of three, led by Dyer, struck south-eastward over the high plateau at 7000 feet and surveyed the mountains nearly to 71° S. They were away from the base thirty-five days and must have covered at least 450 nautical miles. Meanwhile the other party of two, Finne Ronne and Carl Eklund, with fifteen dogs, sledged southward to the Batterbee Mountains and descended to the Sound. After visiting the cache, laid from the air, they climbed the western escarpment, followed the edge of the scarp, descended to the Sound, and reached its southern shore in about 73° S.; thence westward for a week, and came within sight of the open sea. They returned on the floor of the Sound to the Batterbee cache, thence to the Wordie shelf-ice, and by a glacier valley to the north followed a trough eastward into what became known as the Traffic Circle in 68° 40′ S., 66° W., whence they sledged north-westward through the Neny trough to the base, at the end of January, after a journey of at least 920 miles in about eighty-two days.

The Traffic Circle is a basin at about 2850 feet from which five smooth

glaciated valleys radiate; one to Windy Valley, the second to Neny Fjord, the third eastward to the Weddell Sea, the fourth south-eastward to the head of the Lurabee Glacier, "near the major transverse rift in about 69° 30′ S.," and the fifth to Cape Berteaux. It is evidently destined to play a large part in the narrative.

On November 18 a party of three, led by Knowles the geologist, sledged eastward from the base to the Weddell coast and southward down the coast, fixing at 70° 30′ S., 61° 34′ W. "the position of the cape interpreted as Cape Eielson on U.S. Hydrographic Office chart 5411," and then followed the mountainous coast nearly to 72° S. On the small sketch-map it would seem that this Cape Eielson is not, as sketched by Wilkins, at the southern portal of a large strait or embayment, but is a point on the continuous coast of the Weddell Sea. They returned by the same route, having covered at least 650 nautical miles.

On December 22 the Condor was flown south-westward along the northern coast of Alexander I Land, south-westward over Charcot Island, and thence southward to the mountainous west coast of Alexander I Land until in sight of the open water reported by the radio of the sledging party. On December 28 another flight was made south-westward, following the Sound round the southern coast of Alexander I Land, finding that the western mouth of the Sound was rifted like the northern, reconnoitring the mountainous coast to the south-west, and returning *via* the Batterbee cache to the base.

On December 30 the last long flight was made southward along the Sound, then south-eastward over a pass in the eastern wall, across some of the mountains named by Ellsworth the Eternity Range, to the Weddell coast in 72½° S., and thence to beyond 74½° S. From a height of 8400 feet this south-trending coastal range was seen as far as 77° S., while to the east were many patches of open water and leads. They returned to the Traffic Circle by the fourth trough *via* the head of the Lurabee Glacier.

Meanwhile orders had been given for the return of the expedition, the *Bear* having sailed from Philadelphia on October 13, and the *North Star* from Seattle on December 11. The evacuation of the western base began on 11 January 1941 and was completed on February 1, but the sea-ice in Marguerite Bay made it impossible for the ships to get in to Neny Island, and after nearly a month it was decided that the eastern base must be evacuated by air. The *Bear* proceeded to Mikkelsen Island, 112 miles to the north, whither in a few hours, on 22 March 1941, the whole personnel of the eastern base, some twenty-five men, were ferried in two trips of the Condor, piloted by Snow and Perce, and sailed for Magallanes, reaching Boston on May 18.

We have restricted this present summary to the work of the eastern party, which is of more immediate concern to us because it has extended so much the work of the British Graham Land Expedition between 1934 and 1937 in the same area, and we shall await with high interest the further accounts of this very successful expedition. The sketch-map which accompanies the report is on too small a scale to make it easy to read, but the whole account can be followed very readily on the general map of the B.G.L.E. published in the *Geographical Journal* for May 1938, or on the rather larger scale chart of the U.S. Hydrographic Office No. 5411, which is in the Map Room. From a rough plot on this chart, we have measured the lengths of the three principal sledge journeys in nautical miles, allowing nothing for the windings of the route.

THE CHARTING OF THE SOUTH SHETLANDS

The Mariner's Mirror for July 1941 has an interesting article by Lieut.-Commander Rupert Gould, R.N. (ret.), on "The charting of the South Shet-

lands": largely destructive comment upon Professor W. H. Hobbs' monograph of 1939, from the point of view of an officer who served eleven years in the Hydrographic Department. In the course of his study he has traced the history of William Smith, the discoverer of the islands, and identified two men, Miers and Hoseason, whose names appear in the monograph and its discussion.

During his long absence from 1819–21 on the brig *Williams*, Smith's partners had failed, and he found himself on his return joined with them in the bankruptcy. His memorial to the Admiralty, setting out his services to the nation in the discovery of the South Shetlands, received only the answer that My Lords (both of the Admiralty and the Treasury) admit his services but have no funds at their disposal for rewarding him. He served Trinity House as a pilot from 1823, was superannuated in 1839, and admitted to one of the Corporation almshouses in 1840. His chart, among the original documents of the Hydrographic Office, is one of the principal documents in the history of Antarctic discovery.

Mr. Miers, who sent the first account of Smith's discovery to the *Edinburgh Philosophical Journal* for October 1820, had been described as a merchant of Valparaiso, but now appears as a young English engineer recently brought out to Chile by Lord Cochrane to help him in developing the minerals of the country. He was a trained naturalist, and became a Fellow of the Royal Society in 1843.

James Hoseason, the "wholly fictitious character" of Hobbs, had sailed with Smith in the *Williams*, and was according to Lloyd's Registry until 15 August 1825 first mate of the sealer *Sprightly*, belonging to Enderby Brothers, whose master was Edward Hughes.

Hence Hughes Bay and Hoseason's Island.

DEVELOPMENTS IN CHINA

The geographical and economic elements of the present situation in China are analysed by Mr. Owen Lattimore in *Foreign Affairs* for April. He points out that there has been no conquest of the whole of China unless the conqueror has held three strategic points, the province of Shansi, the crossing of the Yellow River at Tungkwan, and the valley of the Han, and that none of these are held by the Japanese. The northern mountains of Shansi form an effective defence in depth against invasion from Inner Mongolia; the eastern mountains provide the best basis for action in the north China plain, if Jehol and Manchuria are in hostile hands, and the southern mountains cover the approaches to Tungkwan, the second vital point. The Chinese troops in these mountains have been able to contain the Japanese in the central Shansi basin. Tungkwan, at the great bend of the Yellow River, commands the only effective route between the North China plain and central Shensi, and it is from Shensi, in turn, that Szechwan can most easily be invaded, for an advance through the Yangtze gorges would be extremely difficult. The third point, the valley of the Han, running northwest from the Yangtze at Hankow (Siakow) towards Shensi, would allow the Tungkwan position to be turned, but four Japanese attempts in the last year to advance up it have failed.

Though the military position has for some time been a stalemate, the gains of Japan should not be underestimated. She holds or partially controls ten Chinese provinces, in particular the fertile, densely populated plains of the lower Yellow River and Yangtze Kiang, and the four great industrial and commercial centres of Shanghai, Tientsin, Hankow (Siakow), and Canton (Punyü). The occupied zone amounts at least to one quarter of the area and one half the population of China: it is predominantly agricultural, producing in addition to food crops, cotton, silk, and soya beans. It was the invader's intention, not

being primarily short of foodstuffs, to gain control of these in order to secure free exchange in the world market, the surplus of which could be used to improve the Chinese supplies of cotton and silk and to extend her own industries. This plan has been thwarted by the failure to crush Chinese resistance completely, and especially by the activities of the guerilla bands. The national forces control five interior provinces, much of Kwangsi, and the strategic positions in Shansi. In parts of Szechwan, Yünnan, and Shensi, there are areas of intensive irrigated agriculture, but the larger proportion is suited for mixed farming, grazing, forestry, or mining. There are supplies of tin, tungsten, and some oil, and much larger resources of coal and iron than in the occupied areas. The influx of refugees, estimated at forty to sixty millions, is therefore not likely to overburden the resources of free China, but to lead to developments on new lines. While Japan is vulnerable to decreasing supplies for her industries, China should in time be able to develop her natural resources and increase her industrial plant. Mr. Lattimore emphasizes the importance, economic and political, of the marginal population, that is the people of the areas partially controlled by Japan: the great majority belong to no political party, and the necessity for the various political parties of free China to persuade rather than to compel them should favour the growth of free institutions.

An article by Professor P. M. Roxby in *Geography* for June supplements the above in several respects. He states that over two hundred factories have been moved westwards into nationalist territory; many other factories have been established by the government; waste land in Yünnan and newly irrigated areas in Szechwan are being settled by refugees; and a system of cooperative units is being encouraged. There are now some two thousand of these, working in small groups and producing mainly cotton cloth and woollen blankets. Their importance however lies rather in the future, as foreshadowing an industrial development more suited to Chinese traditions than the mass production factory. In contrast to this development, the Japanese efforts are based upon the old centralized semi-feudal regime, which was responsible for many past difficulties. The advocates of agrarian reform and peasant emancipation in the national ranks therefore are more opposed to the Japanese than to supporters of the other parties. Thus the former system which, because of an agricultural technique evolved at an early stage, produced dangerous concentration of population, may be replaced by a better balanced and freer organization.

A NOTE ON THE YUNNAN–BURMA ROAD

On recently reading Mr. Patrick FitzGerald's interesting paper "The Yünnan–Burma Road" in the *Journal* for March 1940, I was struck by the apparent depopulation of certain parts of the route as compared with what I saw when travelling across Yünnan on my way to Hkampti-Long and Assam in 1905.

My route then was north-westerly from Laochai on the Red River, at the frontier between Tongking and Yünnan, to Sadiya on the Brahmaputra, in Assam, and, coming up from the south, I passed along a section of what is now the Yünnan–Burma Road between Tsuyung (Ch'u Hsiung) and Tali before striking northwards towards the frontiers of eastern Tibet. I purposely avoided the main caravan routes elsewhere as I was anxious to survey as much fresh country as I could, with the result that I saw a good deal of Yünnan which at that time was not well known, and conducted a route survey which necessitated travelling on foot and enabled me to have a rather more intimate acquaintance with some of the wilder parts of the road than would otherwise have been the case.

As far as my observations went the country was certainly only sparsely populated, yet I generally found it possible to camp or lodge near or in little hamlets

or villages where a few supplies could be obtained, and the country could certainly not then be described as uninhabited.

This differs considerably from the present conditions as described by Mr. FitzGerald, who states that "the section westward from Ch'u Hsiung to Hsia Kuan [Siakwan], almost exactly 200 miles, is mostly very wild uninhabited country." It would be interesting to know the cause of the apparent disappearance of the population from this fairly lengthy section of the road. Possibly it may be due to the effects of the communist rebellions, or to the many "little wars" in China since the formation of the Republic.

From Tali my route diverged from the line of the Yünnan–Burma Road, going north-west to the Feilung–Chiao bridge over the Mekong and on into the Salween Valley. This portion of my route was still less populated, but even there it was surprising to note the number of tiny villages hidden away in the folds of the mountains, particularly as I went northwards up the valley of the Salween, where, despite the evil reputation it has, there were almost always villages to be seen perched on the mountain slopes; these were inhabited by Lissus and other wild tribes. It was not until I finally crossed the Salween–Nmai Hka divide and entered the "Unadministered Territory" of Upper Burma that I really traversed any very large expanses of uninhabited country.

As to the commercial possibilities of the Yünnan–Burma Road, I believe that when peace is restored in western China there will be a gradual development of trade which will certainly make use of the road, and may become of considerable importance. Even in 1905 I frequently met large mule caravans conveying salt and other merchandise, and the local inhabitants often spoke of doing business with Tengchung (T'eng Yueh). The Chinese are extraordinarily enterprising in exploiting all forms of commerce and, judging by my forty years' experience of their trading methods, I believe they are certain to avail themselves of the facilities offered by the Burma Road.

Numbers of Chinese constantly move on the railways and roads in northern China, and I believe that in Yünnan much the same thing will occur if the Yünnan–Burma Road is maintained in reasonably good condition, and if security for travellers can be assured by effective Government control without the imposition of prohibitive taxes or tolls. E. C. YOUNG

TO PUT THE NEW KILOMETRE GRID ON ORDNANCE SURVEY MAPS

In discussing the Report of the Departmental Committee on the Ordnance Survey, at our Afternoon Meeting of 16 January 1939 (*Journal* 93.314) the present Director-General explained, and those who followed concurred in, the Committee's recommendation that the International Metre should be the unit for the grid to be placed on all O.S. maps. There was no mention of the National Grid in thousands of yards which had been introduced about 1933 (*Journal* 82.42), and since then has been shown upon all new sheets as they were re-drawn upon the Transverse Mercator (Gauss Conformal) projection. Our present position is, then, that a considerable part of our maps bear this grid in the yard unit, and that few or none have yet been put on sale with the new metric grid. But we know that it is coming, and in planning for the future, as in the scheme for the National Atlas, it is necessary to know how to transform the old grid into the new.

Major-General MacLeod has therefore very kindly furnished, and allows us to publish, the following figures, applicable to any O.S. map with the yard grid: Fifth edition of the One-inch, Special Sheets of the Half-inch, Fourth edition of the Quarter-inch, the new Ten-mile to the inch, etc.

The Transverse Mercator projection is calculated on a central meridian 2 degrees west, and from the arbitrary origin 49 degrees north on that meridian. To ensure that all coordinates were positive a million yards were added to each x and y. Thus the grid as numbered on the map has a false origin a million yards west and south of the true origin. Some disadvantages of this particular arbitrary addition are pointed out in *Journal* 87.225. It would have been more convenient if 700,000 had been added to the x's and nothing to the y's. This inconvenience has been remedied in numbering the new kilometric grid, for which 400 kilometres instead of a million yards have been added to the calculated x's, and 100 kilometres subtracted from instead of a million yards added to the calculated y's. This brings the whole mainland of Great Britain within the grid lines 100 to 700 easting and 0 to 1000 northing.

Suppose that we are to plot an open grid of 100 km. squares from the new false origin −400 km. +100 km., by interpolating in the 50,000 yard squares of the original grid. Denote the line x equals 100 km. east of the new origin by $x.1$, the line 500 km. north of this origin by $y.5$, and so on. Then we have

$x.0$ is 1,000,000 yards minus 400 km. east, and $y.0$ is 1,000,000 yards plus 100 km. north of the old false origin. Hence since 1 metre equals 1·0936093 yards on the O.S. standard

x.0 is	562 556 yards East	y.0	is 1 109 361 yards North
x.1	671 917	y.1	1 218 722
x.2	781 278	y.2	1 328 083
x.3	890 639	y.3	1 437 444
x.4	1 000 000	y.4	1 546 805
x.5	1 109 361	y.5	1 656 166
x.6	1 218 722	y.6	1 765 527
x.7	1 328 083	y.7	1 874 887
		y.8	1 984 248
		y.9	2 093 609
		y.10	2 202 970
		y.11	2 312 331

and from this table we may easily interpolate the position of any desired line of the kilometric grid on a map which shows the original yard grid. Thus $x.2$ is 31 278 yards east of 750 000, a line of the old grid. On the Ten-mile map 1000 yards should be 1·443 mm. Measurements of the grid may show that on the copy in use 1000 yards is actually 1·439 mm., whence $x.2$ is $31278 \times 1{\cdot}439$ or 45·01 mm. east of line 750 000. For convenient ways of numbering the grid see pages 325–6 of the 1936 paper, Vol. 87. A. R. H.

COLUMBUS IN HAITI, 1492

Professor S. E. Morison, whose little book on Columbus' voyage through the Lesser Antilles in 1493 was reviewed in the *Journal* for May 1939, has since taken up the subject of the Admiral's route along the north coast of Haiti during his first voyage (*Transactions of the American Philosophical Society*, N.S. vol. 31, Part IV, 1940). The particular interest of the matter lies in its bearing on the exact site of the first Spanish settlement in the New World (only temporary as it turned out) named Navidad by its founder. Professor Morison's minute and searching examination of the ground visited in 1492, combined with a study of all relevant literature, puts the question on a new footing; most previous writers, lacking a knowledge of the region, have dealt with it in a somewhat perfunctory way. An experienced yachtsman, capable of appreciating the points at issue from a seaman's view, Professor Morison has also made a careful examination from the landward side, and his conclusions inspire confidence. He

first settles the probable site of the wreck of the *Santa Maria* on the reefs which fringe the coast; then, on the basis of the Admiral's subsequent doings in relation to the natural features of the land, decides in favour of a spot close to Limonade Bord de la Mer, as the site of Navidad. This is found to be the only place which fits in at all with the navigator's own account and other early documents. The precise site of Guacanagari's village is more doubtful, but can be fixed with some probability. The memoir is profusely illustrated with maps and photographs.

SWEDEN: DALARNA STUDIES

The student group of the Le Play Society, directed by Mr. K. C. Edwards, carried out in 1939 a number of field studies in the Lake Siljan area of Dalarna, or Dalecarelia, the present administrative district of Kopparberg, and some of the results have recently been published as 'Sweden: Dalarna studies' (1*s* 6*d*, obtainable from the Geographical Association). These give an interesting outline of the main geographical features of the region and, in more detail, of the activities of the population in relation to this environment. Lake Siljan lies in the valley of the East Dal in the north of the central lake depression of Sweden, and the surrounding area affords an opportunity of examining the effects of quaternary glaciation and recent land movements on the ancient surface of granitic rocks. In the section on geology it may be questioned whether the Siljan horst is really a horst at all, it has the appearance of a bathylith, but it is difficult to draw conclusions from the description given. In regard to the distribution of settlement, the four beach levels below the lower pre-glacial platform are important: the lowest beach affords the most fertile land, and the villages are in general placed on the slope intervening between it and the next. Though seventy-five per cent of the area is forested, agriculture is the chief occupation, based upon the growing of fodder for animal husbandry. In earlier times it was the practice to establish summer settlements on the poorer areas to pasture the cattle; this system of *fabod* is now declining through lack of labour, higher production of fodder on the arable land, conflicts with the timber companies, and the necessity for concentrating dairy work in more accessible areas. Average holdings are now small, and it is probable that only the development of the tourist traffic and the timber industry have prevented the population from declining even more than it has done recently. These studies convey the impression of a sturdy and energetic community enjoying a high level of prosperity and preserving its traditional independence and culture. Though, as Sir John Russell remarks in his foreword, the information contained here is available in good Swedish publications, it is useful to have it summarized from direct observation, apart from the benefit accruing to those who collected it.

OBITUARY

LORD RENNELL OF RODD

Few men have left behind a sweeter memory than Rennell Rodd.

It is of the man himself that I write these few lines; not of his actions or of the many instances from and by which our country has benefited so greatly, but of the being from which those actions sprang. A fine brain and ability to use it. Of great courage both physical and moral, opportunities were granted to him that this quality was not wasted. Possessing literary and artistic knowledge and cultivation far beyond the average and an unerring taste and discrimination in their application. With these gifts there was combined a modesty and natural simplicity—coming from real generosity of heart and mind—that never allowed any display which might have caused a companion less well endowed than himself to feel any sort of inferiority of brain, of courage, or of cultivation. What he cared for was the subject, not his knowledge of it or the display of that knowledge.

The writer of this short appreciation, with the privilege of a close friendship of fifty years, remembers days spent at Athens and other places and at another time in Rome, when Rennell Rodd, with vivid speech and ever-increasing enthusiasm, would bring to life again the persons, beauties, and interests of long-past ages. Others will write of his actions and of the many important and useful contributions he made to the State. His own book describes his varied life. Here is an instance of his entire unselfishness. He had written some passages of great interest which were perhaps critical of a past administration. When it was pointed out to him that those passages though of great interest and also of very good sales value might cause distress and perhaps embarrassment without showing any real construction for the future, he withdrew them at once.

His capacity for friendship was infinite, his acquaintance large and varied. Empresses, kings, crossing sweepers, princes, poets, peasants. He was at ease with all and they with him.

His connection with our Society, of which he had been a Fellow for close on fifty years, was intimate not only personally but in his forbears and his descendant, for Major James Rennell, the distinguished surveyor and oceanographer whose bust stands in a prominent place in our building, was his grandfather, and his son Francis, who succeeds him, is a Gold Medallist.

W. E. GOODENOUGH

ELECTIONS

The following have been elected Fellows of the Society:

On July 1, 1941: Ronimund Bissing, F.R.S.A.; F/O. E. J. Matthews; Mrs. Eldred Oliver; H. E. Sweet; Ivor L. Williams.

On July 21, 1941: Flt/Lt. F. W. Clarke, R.A.F.V.R., B.Sc.; Percy Evans; Major P. le Grand Gribble; Captain E. N. Hebbert; Rev. Thomas May, M.A.; Miss F. J. Peters; E. H. W. Ralphs; Philip A. Snow, B.A.; R. Sutcliffe; Miss Diana Ward.